HARDWARE . . . . SOFTWARE . . . . AT HOME . . . . IN BUSINESS

computing today

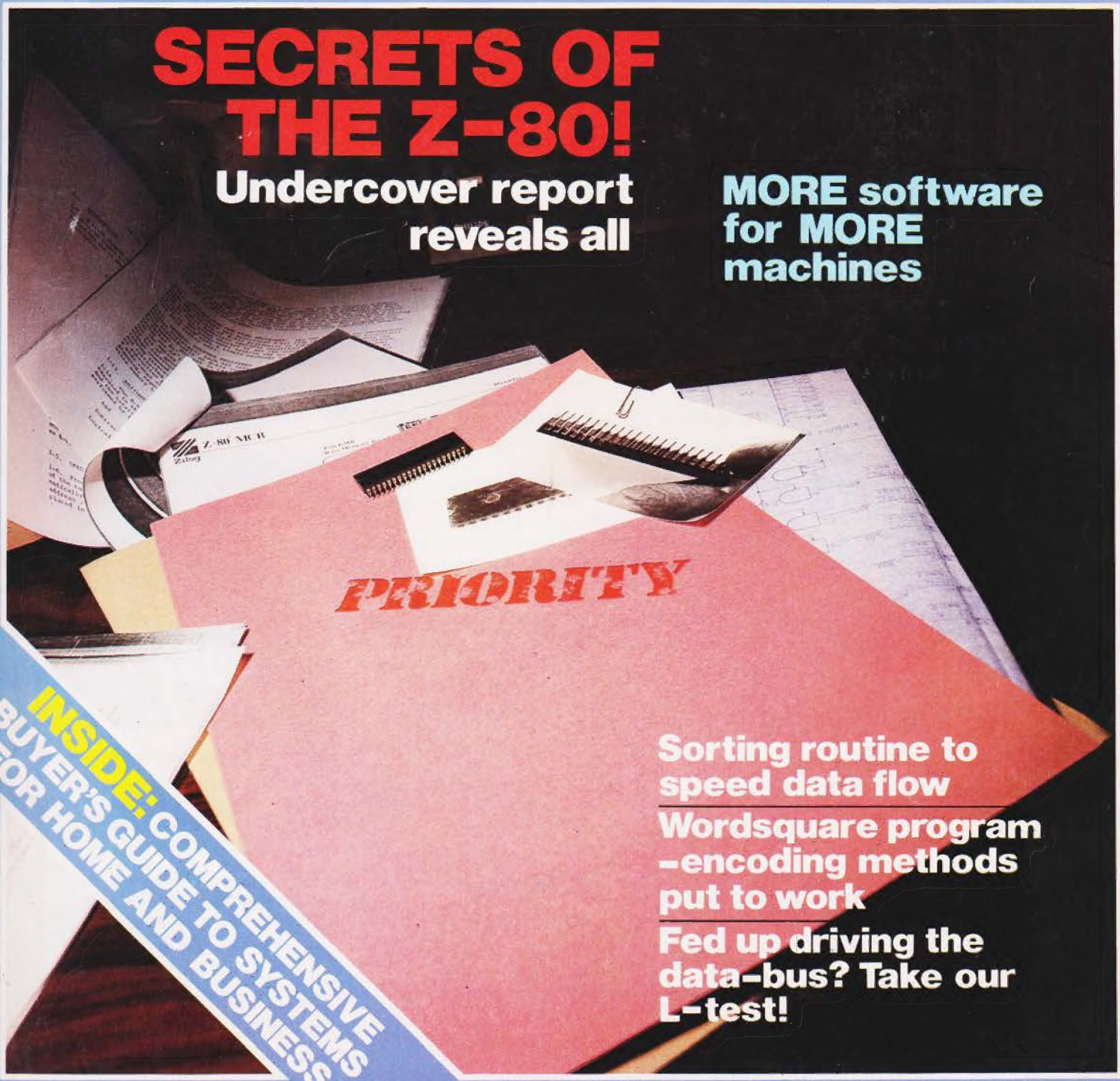
FOR THE BUSINESS OF MICROCOMPUTING

FEBRUARY 1981
ISSN 0142-7210
60p

SECRETS OF THE Z-80!

Undercover report reveals all

MORE software for MORE machines



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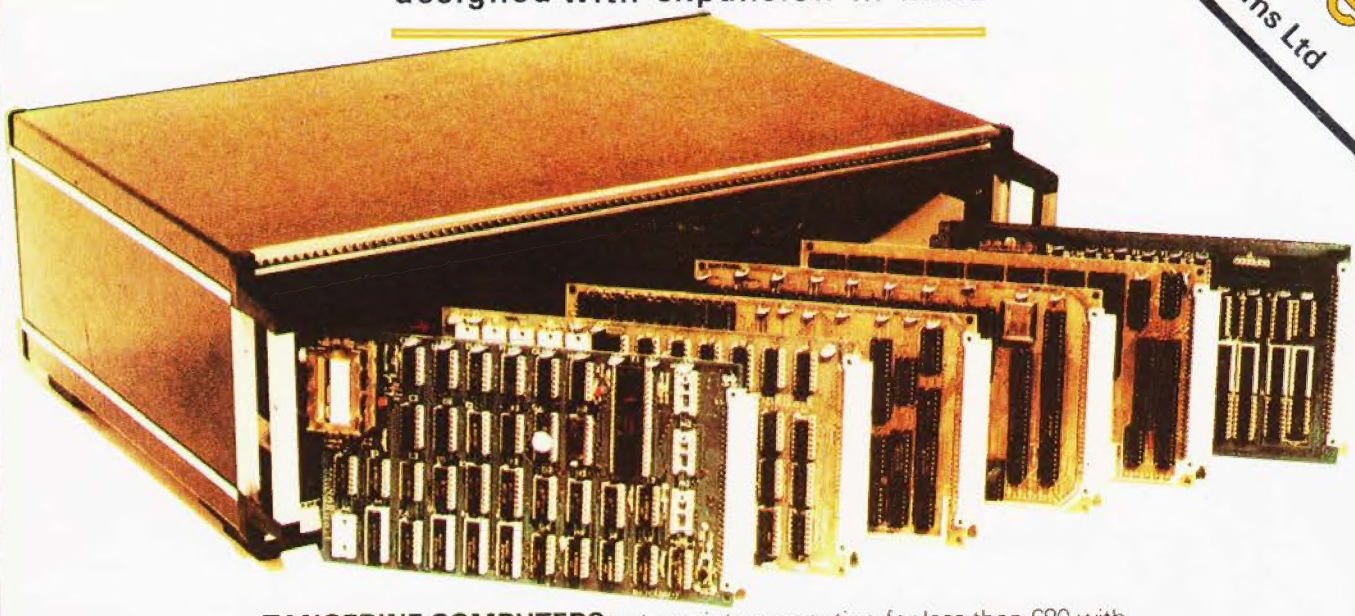

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Comart Microcomputer dealers are located strategically throughout the country to give support, guidance and assistance. In the event of difficulty contact Comart direct.

comart communicator

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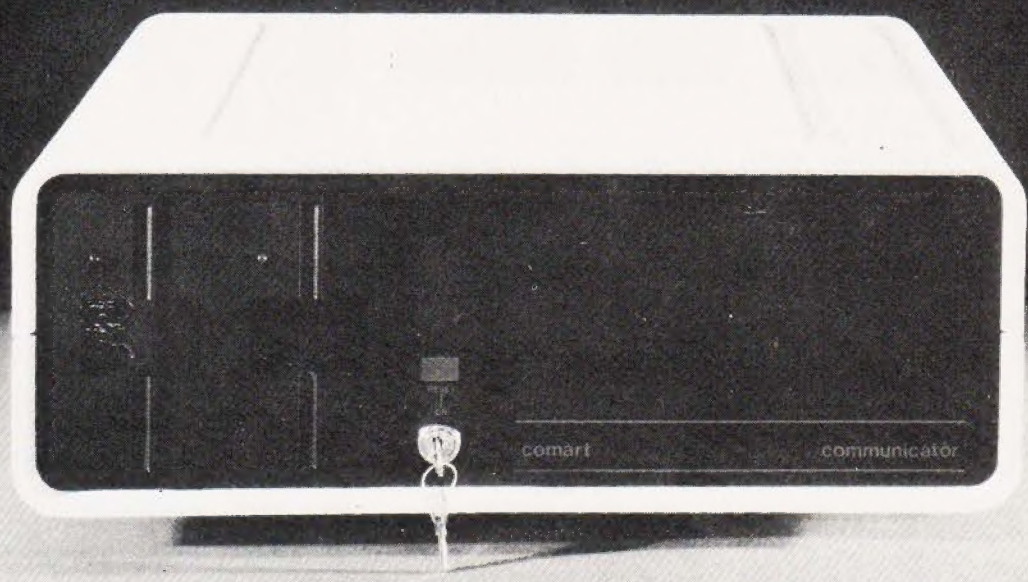

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BREADBOARD 80

Held as usual at the Royal Horticultural Society's New Hall, Breadboard once again proved to be a great success. By lunch-time on the opening day more people had arrived than on the whole of the first day last year. Our celebrity guest was Brian Rix, star of the Whitehall farces, and of course, famous (or infamous) for dropping his trousers, which, we are glad to say, he did not do at Breadboard 80! The attractions were numerous — suppliers of components, home and business computers, CB accessories, space invasion games, hi-fi and disco equipment as well as all the leading electronics magazines to name but a few. The Modmags stand (that's us folks!) was the undisputed star attraction(?) mobbed by huge crowds. We presume this was because our staff were so helpful and pleasant but there is a sneaking suspicion that it might have had something to do with the two Space Invasion games we were displaying. Free games were offered to all, with the opportunity of winning your own machine with the highest recorded score. Ah well ... The show was certainly the electronics enthusiast's idea of paradise with every conceivable electronic noise pounding the ears and millions of devices to delight the eyes. If you weren't there this year to see it all, don't miss next year. Make a note in your new diary for November the 11th to 15th for Breadboard '81, it'll be better than ever, definitely not to be missed!

FILE IT AWAY

Into bondage? Rather than leaving your floppy discs lying around and getting dusty, why not file them neatly away? As an alternative to the box type of filing system the Leicester Computer Centre are offering an expandable ring binder system for either 5¼" or 8" discs. The basic unit is complete with five leaves, each holds four discs, costs £4.95. If you just want the leaves they cost £1.55 per five and will fit into two or three ring binders. The 8" leaves hold two discs. The Centre specialises in Apple software and among their range can be found th Correspondent text editor, Apple DOC development package and Tridee, a three dimensional graphics program. The Centre can be contacted at 109 Queens Road, Leicester LE2 1TT.

EMBARRASMENT CORNER

In our December issue we published a game called 'Cells and Serpents' which we likened to the popular 'Dungeons and Dragons'. The name 'Dungeons and Dragons' is in fact the registered trade mark of TSR Hobbies Inc. of Lake Geneva, Wisconsin USA. We apologise to them and their UK agents, TSR Hobbies (UK) Ltd for its use without their permission.

SORTING IT OUT

Users of the AM Jacquard 425 Word processor can now use it for limited record processing with the aid of a new sort program from MGM Associated of 19 St Andrews Road, Great Malvern, Worcs. Supplied on a single floppy disc the program costs £275 and can be used to produce such vital items as selective mailing lists. Data can be selected with up to ten sets of criteria and there are six comparative qualifiers. Both alpha and numeric data can be processed. The program has also been made user friendly in that it will tell the operator approximately how long the job will take.

ADVICE FOR FREE

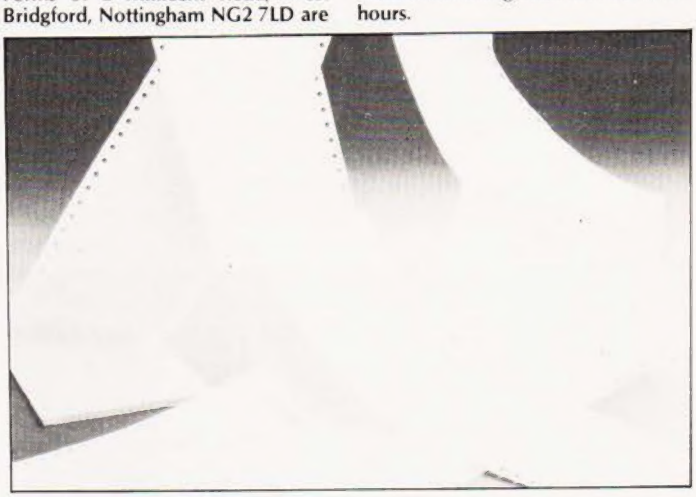
If you are considering computerisation of your business or using a word processor and are not sure of all the implications, then a series of new leaflets from the Industrial and Commercial Finance Corporation might help. All have been written by practising consultants and are all free. The four computer based booklets cover successful first time use, word processing, micro based business systems and how to negotiate the contract. For your copies contact ICFC Consultants at 5 Victoria Street, Windsor, Berks SL4 1EZ.

TAKING STOCK

TSE Computer Supplies have finally decided that enough is enough and have moved to larger premises. Their new address is 13 Beaumont Road, Chiswick, London W4 5AL and the new telephone is 01-747 3366. They are still making Daisy print wheels and supplying a range of diskettes but now in rather more comfortable surroundings.

STICKY ROLLS

With the ever increasing use of word processing equipment, self adhesive labels are becoming another of those office necessities. MBF Business Forms of 2 Millicent Road, West Bridgford, Nottingham NG2 7LD are trying to solve the supply problems with a range of 35 sizes available on continuous web in singles, double, triples or quads. Special sizes are available to order. Stock sizes are available on 48 hour despatch with most orders being dealt with inside 24 hours.



RUB IT IN

With a name mildly similar to that well known substance that you can rub on your loved one's chest when she's got a cold (you should be so lucky!), Commodore have boldly announced their new computer. Specifically aimed at the home and education markets it has been produced by their Japanese subsidiary and was launched in that market first. In appearance it is very like the Acorn Atom but it does offer PET BASIC (Microsoft), 5K of RAM, colour, sound and optional expansion. The games features include joystick and paddle type controls and it is understood that programs can be 'plugged-in' à la TI 99/4. Estimated price for the system is "under £200" but it is expected that by the time you have added the extra RAM and the other promised peripherals the price will resemble that of the PET. A normal colour TV set is used as the output device and the display is a rather wierd 22 characters by 23 lines. Perhaps the Japanese like square pages? No release date for the UK has yet been announced but it will probably emerge into the public eye around Easter at one of the big computer shows in the US. After the problems with the launch of the 8032 SuperPET it can only be hoped that Commodore get everything straight before they spring it on the general public. In case you're still pondering, the name is VIC!

ON COURSE

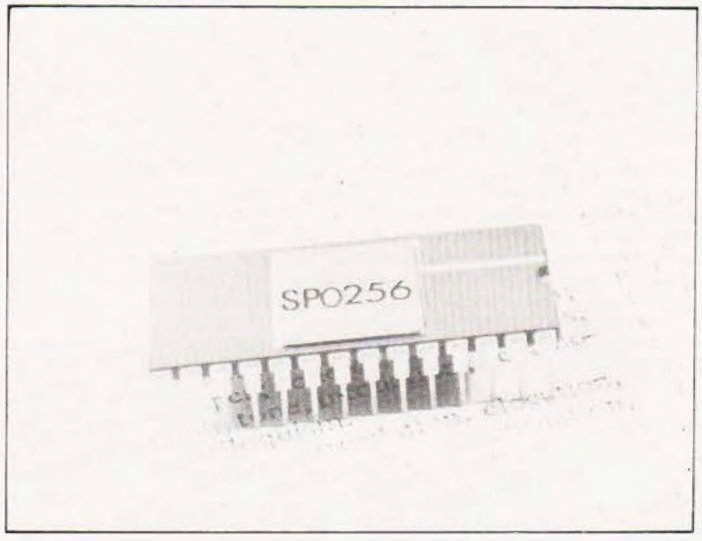
Midwich, the distributors of the Nanocomputer, are running their five day 'Hands-on' courses at the University of East Anglia again. Each participant gets his or her own Z80 based machine and the course is mainly practical. For further details of the course and the associated arrangements contact Midwich Computer Company at Hewitt House, Northgate Street, Bury St Edmunds, Suffolk IP33 1HQ. Cambridge Micro Computers has just issued a fourteen page brochure on its range of computer courses. Among those on offer are an introductory course on micro design and a Z8000 programming session. For your copy of the brochure contact Cambridge Micro Computers at Cambridge Science Park, Milton Road, Cambridge CB4 4BN.

BUS INSPECTOR

Test engineers and servicemen, not to mention the home constructer, will probably appreciate a new test device from Karo Electrical Developments of 20 Cross in Hand Lane, Lichfield, Staffs WS13 7BY. Consisting of a logic pulser and 32 logic level detectors it will track down open and short circuits on up to 16 separate locations simultaneously. By changing the test probe the device can be converted into an IC logic monitor. Prices and technical information are available directly from Karo.

SUPER UK ENHANCEMENTS

Users of Ohio or Compukit machines with an urgent need for expansion can now go rack-mounted. Premier Publications are offering a six slot motherboard with or without PSU called TES. Currently available products for use in the rack are an 8K static RAM card and an 8K EPROM card. Both are available in kit form and a new extended monitor is also offered to reside on the EPROM card. Coming soon will be a 'Toolkit' type of utility ROM which will offer the usual gamut of desirable extras. Prices for TES are £28.50 for the bare motherboard, £37.50 for the RAM card, £39.50 for the ROM card and £39.95 for the 'Toolkit'. Premier Publications can be contacted at 12 Kingscote Road, Addiscombe, Croydon. An A4 stamped addressed envelope is requested with all information enquiries.



SILICON SPEAK

It never rains but it pours. Two of the major chip companies have announced speech synthesis devices in the last couple of weeks. First out of the bag was National with its Speech Processor Set which is a kit of chips that can produce male or female speech in many languages using a compressed vocabulary stored in ROM. As well as a standard set of words, custom vocabularies can be stored. The interesting feature is that the stored speech is compressed *real* speech rather than being truly synthesised. This means that the voice you get out is recognisably the voice that you put in. The chip set is directly addressable through a microprocessor bus or by TTL logic and with around 100 words per vocabulary set, many areas of speech response equipment open up. The second synthesis chip comes from General Instrument and is a single 28 pin device. Internal storage is some 16K with the facility to expand externally. The user is allowed to trade off storage requirements for high quality speech with lower quality useage. Commonly used utterances can be stored once and then strung together, thus saving memory. The device is microprocessor compatible and each of the stored segments can be accessed by a single eight bit address. Further product information can be obtained direct from National Semiconductor (UK) Ltd., 301 Harpur Centre, Horne Lane, Bedford and General Instrument Microelectronics, Regency House, 1-4 Warwick Street, London W1R 5WB.

ELECTRO PRINTING

Costing under £200 this 32 column printer has to be one of the cheapest around. ASCII format data can be accepted in both serial and parallel forms and the standard 64 character set can be produced on aluminised paper. Cased and ready to go, the unit is aimed at the data logging and industrial marketplace but doubtless it could be used for other functions such as program listing. The font can be changed and even replaced with a graphics set for pictorial output. For full details on the new unit and its companion range contact Digitronix at 10 Burners Lane, Kiln Farm Industrial Estate, Milton Keynes.

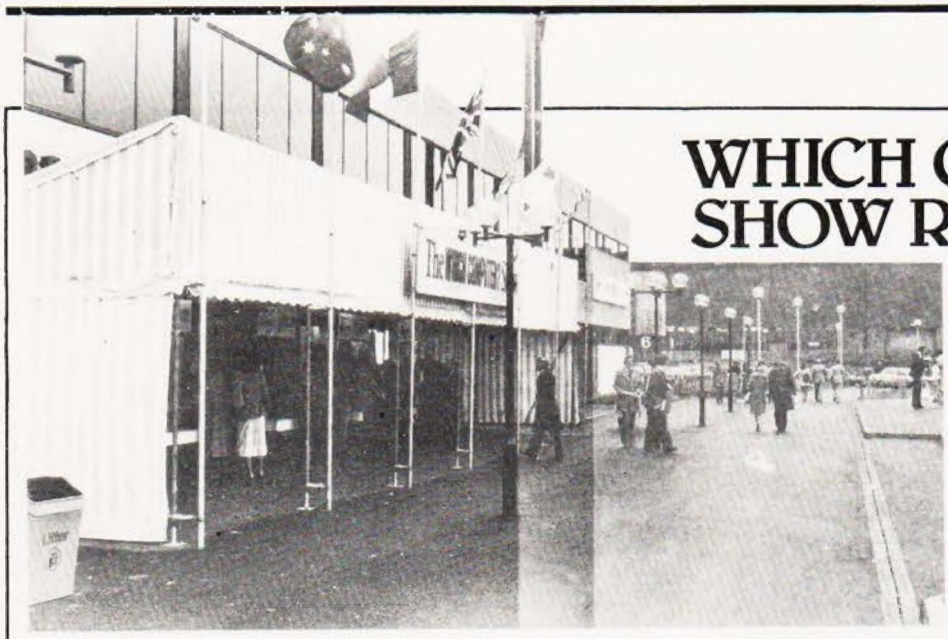
CLUB CALL

The Southampton Amateur Computer Club has just celebrated its second birthday with the launch of its own micro. It is based around a Z80 and will be available from Greenbank Electronics of Merseyside. Anyone interested in the micro or the club and its local offshoots should contact P G Dorey at the Dept of Physiology & Pharmacology, Southampton University, Bassett Crescent East, Southampton S09 3TU. As you can see from a later article in this issue there are strong connections between the world of Amateur Radio and micros. The Cornish Radio Amateur Club has formed a local computer club for the Cornwall area and anyone in the locality should contact Richard M Frost at Trecarne, Alexandra Road, Illogan, Redruth, Cornwell TR16 4EA. The North of England is well served already for computer groups but yet another has sprung-up. Those in the Chorley area now have their own club which meets on alternate Tuesdays at a local hostelry. Anyone interested in a pint and a chat should contact Rod Wilson on Chorley 71875 or Chris Hicks on Chorley 78376. Back to London now with an update for the East London Amateur Computer Club. They now meet every second and fourth Tuesday of the month at the Harrow Green Library in Leytonstone London E11. And back to the South Coast once more to announce the formation of the Bournemouth Area Computer Club. Anyone in the locality who's interested should contact Peter Hibbs at 54 Runnymede Avenue, Bournemouth, Dorset BH11 9SE or the Kinson Community Centre at Northbourne.

HUMBLE PIE

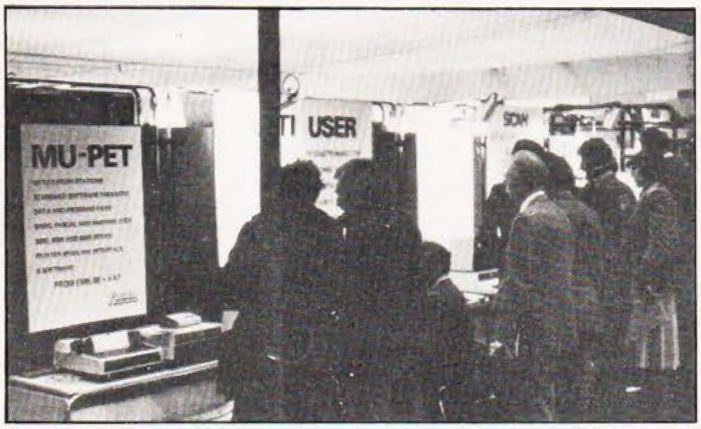
The computer featured on our cover last month was not our new entry into the high-powered desk-top computer market as some of you may have thought but the well-loved Zenith Z89. Our name was placed over the Zenith logo to avoid the misconception that the system could produce colour graphics, these were actually produced on an Apple. Our thanks are due to Heath Electronics (UK) for the loan of the Z89 system.

WHICH COMPUTER SHOW REPORT



The Which Computer Show recently opened its doors, at the NEC in Birmingham, and attracted suitable hordes of pin-stripe computing persons. The show was billed as "The Small Business-man's Computer Show" and kept the promise well with a good array of companies all intent upon the first-time, or small system, user. Some idea of the sheer size of the exhibition can be gauged from the photos herein. Most of the large companies built their own stands of sizable proportion.

Overall though, there was a distinct air of refinement rather than revolution. Nothing really new, just old and improved!



Commodore were out to prove that Multi-User Pet has a lot to offer.

Honeywell must have believed it, they were giving PETs away!

With system prices at £10K+ Texas must be speaking metaphorically!

Undoubtedly the most ingenious stand in the place. I just wish we had this much space in the London hotels.

NEW PARTNER

Almarc Data Systems, the UK distributors for Vector Graphic equipment are introducing a new model called VIP. The Vector Intelligent Partner is intended to be a low-cost desktop micro for word processing and other small business applications and is supplied with a single floppy disc unit, 56K of RAM, one serial and three parallel ports and a VDU. Expansion is by way of the rest of the Vector Graphic range. Software under CP/M will run on the disc unit and this includes items like Wordstar. For further information contact Almarc whose address can be found in the Buyer's Guide.

CODE RE-BUILDER

With the ever increasing popularity of text processing systems expanding into the home market, printers like Selectrics and similar non-ASCII code based output devices can occasionally cause the odd headache. The problem is the conversion of the ASCII code into the appropriate signals to drive the printer. An Intelligent Interface Adaptor unit is available from Micro Xeno which can be supplied pre-programmed for a wide range of different terminals and connects directly to the microprocessor bus. As well as re-structuring the code sent to the terminal it is also capable of taking output codes from the terminal and converting them back into ASCII. For devices with paper tape facilities the correct ASCII control codes are obeyed. The unit is also equipped with a 300 baud cassette tape interface for off-line storage of documents. Because the conversion table between ASCII and the required code is stored in EPROM the device can be re-programmed at a later date if your needs change. Micro Xeno can be contacted at Xeno House, 224 Wellington Road, Perry Barr, Birmingham B20 2QL.

OSI IN UK

Ohio Scientific, the people who brought you the Superboard, have finally established a UK marketing and sales operation at Langley in Bucks. The existing nine independant dealers will now become part of a 30-dealer UK network with full technical support. Ohio are intent on breaking into the profitable business market with an expected 20 systems per month. The main effort of the operation is being given to the C2D and C2-OEM systems, full details of which can be found in the Buyer's Guide at the back of the magazine. These are both intended for the business and scientific markets, the C2-OEM features a 6502 running at 1 MHz with 48K of RAM. Being card based the unit plugs into a backplane and the basic system cost is around £2000. Winchester technology discs are available along with a variety of other add-ons. Software for the systems is also being developed by UK companies, word processing and small business packages at the moment. For more information contact Alan Davies on Slough 77514.

HAVE VDU, WILL TRAVEL

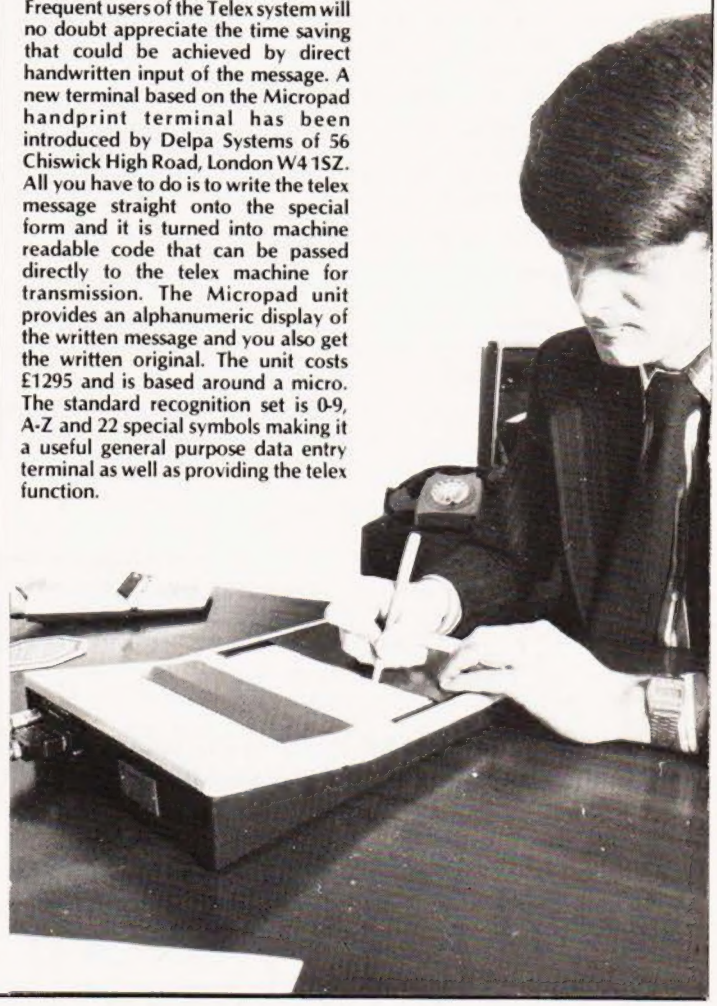
Cifer Systems, one of the VDU manufacturers that is regularly featured in our Buyer's Guide, have now opened a Northern Sales and Service office to cope with increased demand. Situated in Nottingham at Newton House, Maid Marion Way, it is headed by Roger Bowen. The telephone number is 0602-410551.

VISIBLE EXPANSION

As well as making VDUs, Cifer have also produced an intelligent version of their 2600 terminal called the 2684. Currently being marketed by Rohan Computing of 52 Coventry Street, Southam, Warwickshire CV33 0EP, it offers a standard VDU with a mini floppy disc running under CP/M with its own CPU. Both the VDU and processor functions are controlled by Z80s with up to 64K of RAM. Disc storage can be expanded with twin external 8" drives and a number of I/O ports are available for printers etc. Rohan also supply the OKI range of printers from the popular Microline 80 to the new Microline 83 which features 120 cps bi-directional printing across a 120 column line.

WRITE NOT TYPE

Frequent users of the Telex system will no doubt appreciate the time saving that could be achieved by direct handwritten input of the message. A new terminal based on the Micropad handprint terminal has been introduced by Delpa Systems of 56 Chiswick High Road, London W4 1SZ. All you have to do is to write the telex message straight onto the special form and it is turned into machine readable code that can be passed directly to the telex machine for transmission. The Micropad unit provides an alphanumeric display of the written message and you also get the written original. The unit costs £1295 and is based around a micro. The standard recognition set is 0-9, A-Z and 22 special symbols making it a useful general purpose data entry terminal as well as providing the telex function.



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* CATACOMBS - fantastic 3-D maze game. Lose yourself in this three-dimensional puzzle for hours on end! Available NOW for UK101 (TRS80/VG/SHARP soon) £9.95.

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MICROSPEAK

Users of the ever-popular 6502 microprocessor have a real treat in store for them in our March issue with the start of a major series on machine code programming. Produced by a 6502 specialist it will deal with all the intimate details of this CPU and how to get the best out of it.

As a part of the series we will also be presenting a mini-assembler allowing you to use the slightly less daunting assembly language. This is written in BASIC and will be a useful addition to anyone's program library in its own right.

Serious programmers or those just seeking a new way to do things should not miss next month's magazine, you may never get another like it!

FOR BUSINESS, OR PLEASURE?

Commodore's much vaunted 'SuperPET' is, according to the publicity material, aimed straight at the small business market. We took the system and a pile of Commodore's own software and tried it out. The report on just how the machine measured up is something anyone interested in computerising their business will want to read.

HOLED OUT?

Designed for those busy executive types who can't get away to the 19th hole, we give you a computerised golf game. Suitable for virtually any machine that runs BASIC it will, at least, keep them in the office!

6800 LIVES OK

Conway's "Game of Life" has been featured before in the pages of CT but never in 6800 code. This program is well documented and, although it is designed for the SWTP system, it should be adaptable to many other 6800-based machines.

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

D S Peckett

Sherlock and Watson would have been proud of the logic displayed in this investigation of one of computing's dark secrets.

The Z80 is generally recognised as being just about the most powerful eight-bit micro around, and it's used in personal computers such as the TRS-80, the NASCOM and the Sharp MZ-80K. Zilog's literature for the Z80 describes its repertoire of 158 types of instruction, with a total of 696 possible opcodes (plus data).

You may think that this should be enough for anyone, but it's actually possible to find, on most Z80s, 88 more usable opcodes. These effectively give you access to four extra eight-bit registers; the more machine-code programming you do, the more you'll appreciate that you can't have too many registers.

This article explains what these instructions are and why they exist. It also gives a program which will test the Z80 in a TRS-80 to see if it possesses them.

Z80 Architecture

To start, though, let's remind ourselves of the Z80s architecture. Figure 1 is a diagram of the micro.

The device has two sets of working registers, each set comprising a single accumulator (A), a flags register (F) and six general-purpose eight-bit registers (B-L); the six registers can be combined into three 16-bit registers. The micro has instructions to select the register set in use at any time.

The Z80 also has the usual program counter (PC) and stack pointer (SP), and two 16-bit Index Registers (IX and IY). We won't bother with I and R here.

The Z80 is a development of the Intel 8080A, from which it inherits the A-L registers. The second set of registers (A'-L') aren't in the 8080A, which also lacks IX and IY.

As well as the extra hardware, the Z80s designers also managed to cram in a lot more instructions. The Z80 can perform all the earlier micro's instructions, using the same opcodes, and has many more of its own. The extra instructions cover features such as bit testing, relative jumps, register shifts and block moves of data. Most importantly, as far as this article is concerned, they also provide a comprehensive set of indexed instructions.

These help to get round a curious limitation of the 8080A, inherited by the Z80, which is that a lot of references to memory have to use the register pair HL as a pointer. This sometimes leads to clumsy programming. For instance, to add the contents of address 1234H to the accumulator, we have to use:

```
LD      HL,1234H      ;HL = 1234H
ADD     A,(HL)        ;A = A + DATA
```

The Z80 extends this type of addressing in order to have an indexing capability.

Indexed Addressing

If you look at a description of the Z80s assembly-language, you'll soon see (I hope) something interesting about the way the micro does its indexing. Whenever an instruction has a form using (HL), it also has an indexed form. Thus we have:

```
LD      A,(HL)      LD      A,(IR + d)
BIT     7,(HL)      BIT     7,(IR + d)
```

I'm using 'IR' to represent 'IX or IY'. Furthermore, there are no indexed instructions which do not have (HL) counterparts

I hope the suspicion is now growing that the two index registers and HL are closely related. This suspicion becomes a certainty when we look at the machine code which the micro actually executes.

For example, the Hex code to perform 'ADD A,(HL)' is 84; the equivalent code for 'ADD A,(IX + d)' is DD 84 dd, where 'dd' is the displacement expressed in two's complement form.

To take another example, the Hex code for 'BIT 7,(HL)' is CB 7E, and that for 'BIT 7,(IY + d)' is FD CB 7E dd. If you study your list of Z80 instructions (if you haven't got one, you shouldn't be reading this article!) you will see a remarkable consistency. Every (IX + d) instruction has an opcode formed by prefixing the equivalent (HL) command by 'DD', and adding

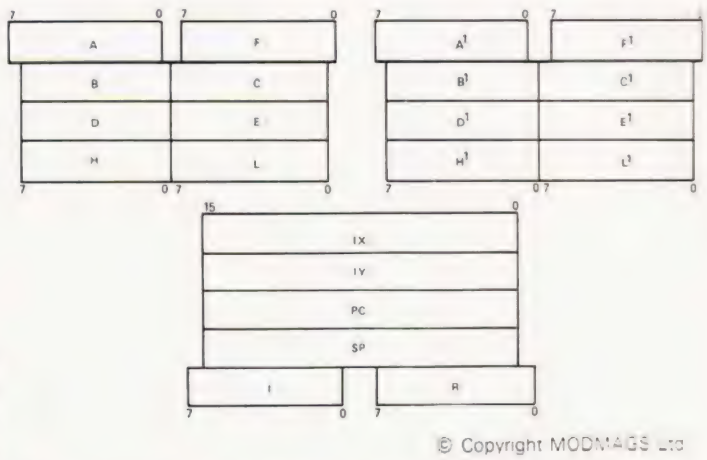
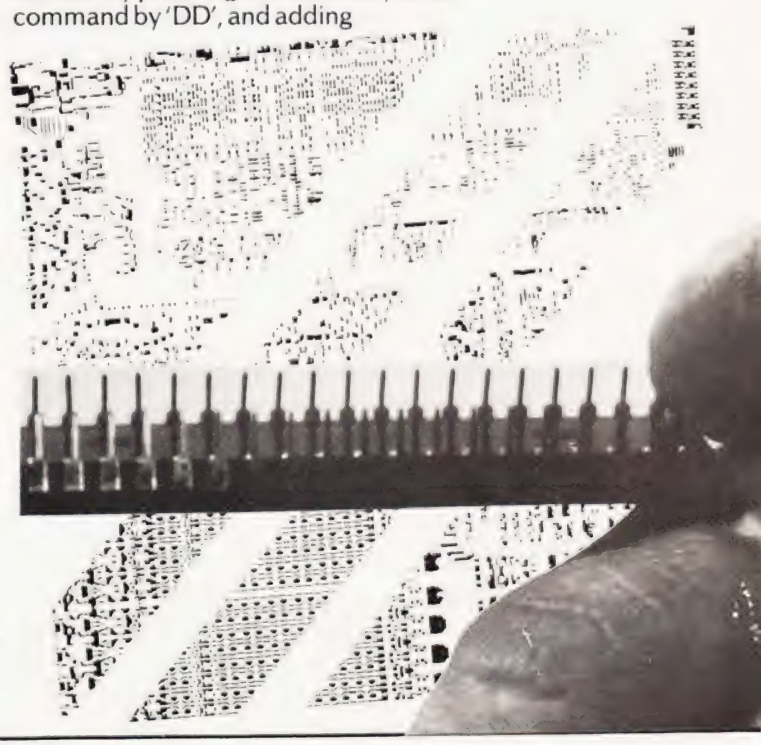


Fig.1. What the Z80 looks like inside according to the manuals.



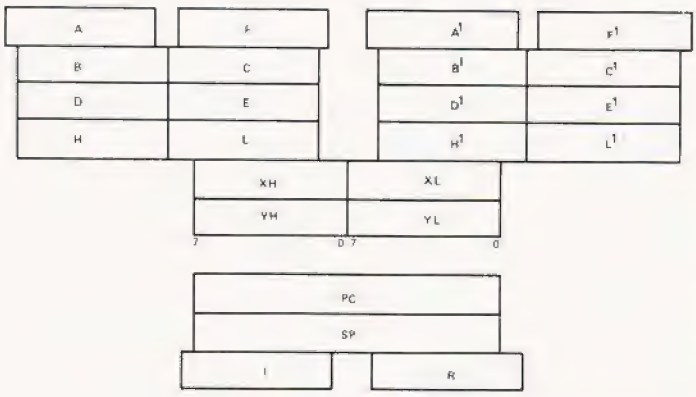


Fig.2. What it might look like inside if you are lucky.

'dd' to the end. The (IY + d) commands are formed by using an 'FD', rather than 'DD', prefix.

This observation also partly explains why indexed instructions execute more slowly than their (HL) counterparts — the opcodes are two bytes longer. Reading the extra bytes takes time.

From this sort of evidence, I'm pretty certain that the Z80 uses the same internal logic to decode (HL) and (IR + d) instructions. The actual register selected is defined by the instruction's prefix, or lack of one.

Possibility Of Extra Instructions

Having seen how the Z80 gets at its indexed instructions, an interesting possibility arises. So far, we've only considered HL as a 16-bit register, but it can, of course, be treated as two eight-bit registers. What happens if we take, say, the opcode for 'LD A,H' and prefix it with DD?

When I do it to the Z80 in my TRS-80, I find, amazingly enough, that A is loaded with the high byte of IX. No other registers have been altered. Lo and behold! I have an extra instruction. Obviously, it goes a lot further, or else I wouldn't be writing this!

On all the Z80s I've checked, the close relationship between HL, IX and IY allows each of the index registers to be treated for many purposes as two eight-bit registers.

Since, in general terms, you can't have too many internal registers in a micro, this is potentially a very valuable discovery. It's usefulness obviously depends on whether or not you're using the index registers as index registers, but it gives an extra two eight-bit registers for each index register you can spare.

Extra Instructions Available

Let's have a look now at just what we can do with our extra registers. First of all, some nomenclature — I'll call the two bytes of IX 'XH' and 'XL', and the two bytes of IY 'YH' and 'YL' (Fig.2). With these register names, we could, in the example above, use the mnemonic 'LD A,XH' for the instruction with the opcode DD 7C.

When I first discovered these extra commands, I hoped that XH, etc., could be used in *any* Z80 operation that used H or L. For instance, we could have 'LD YL,B', 'SUB YH', 'CP XH', 'BIT 3,YL', etc. Unfortunately, the Z80 does not seem to work quite that way.

In the first place, it's not possible to have, for example, 'LD XL,H'. This is not too surprising. The instruction would be generated by prefixing the code for 'LD L,H' (ie 6B) with DD. However, the micro would not know whether 'DD 6B' meant 'LD XL,H' or 'LD L,XH'; it actually settles on 'LD XL,XH'. So, we cannot mix H or L with the extra registers in a single operation.

The second limition is more obscure — ie, I don't know why it exists! The extra registers will only work in the operations inherited from the 8080A, and not in the 'new' Z80-only instructions. As far a I can see, the difference is related to the fact that all the 8080A-compatible instructions use single-byte opcodes (plus data if it's appropriate), while the Z80 specials all use two bytes. Whatever the reason, it means that you can't use BIT, SET, RES, rotates or shifts. Still, the extra commands are free, so we can't complain.

Table 1 shows all the 'extra' instructions which are possible. It does not give their opcodes — you can form these by using the 'DD' and 'FD' prefixes as appropriate.

A small word of warning. I've shown the extra commands in the standard Z80 mnemonic format. However, it's no use trying them with your assembler, because it won't recognize them! You must either write a new assembler, or resort to hand coding.

It's important to remember that these extra instructions are 'unsupported'. That is to say, they don't appear in the official Z80 literature, and so there is no guarantee that every Z80 will execute them successfully. It may well be that, at some stage, Zilog will modify the micro's internal workings, and the change will stop it responding to these commands. Obviously, if a given chip obeys them once, it will obey them every time.

If you want to use them then you must test your micro to see how it responds to the opcodes. The best way is via a series of short machine-code program segments, preferably controlled via a high-level language such as BASIC so that you can evaluate the results easily.

Table 1

Extra Instructions Available

Mnemonic	Test Segment
LD r,XR	LD1
LD XR,r	LD2
LD XR,data	LD3
LD XR1,XR2	LD4
ADC A,XR	ADDSUB
ADD A,XR	ADDSUB
SBC A,XR	ADDSUB
SUB XR	ADDSUB
INC XR	INCDEC
DEC XR	INCDEC
AND XR	ANDORX
OR XR	ANDORX
XOR XR	ANDORX
CP XR	COMP

Notes:
'r' — Register A,B,C,D or E
'XR' — 'Register' XH,XL,YH or YL
'XR1', 'XR2' — Any XR
The mnemonics follow the usual Z80 conventions

Testing Your Micro

The first step in designing such a self-test program is to decide just what needs to be done. Is it, for example, necessary to check that 'LD A,XH', 'LD B,XH', 'LD C,XH', etc *all* work properly? I think not. If we can show that, say, XH can be loaded into B, then it's virtually certain that it can be loaded into A, C, D and E also. It *is* worth checking that each extra register can be loaded successfully into a normal register.

It is convenient for the program to check the extra instructions in logically-related blocks; I suggest that we can use the eight blocks shown in Table 1. Figure 3 shows the test sequence, which goes from the 'simpler' instructions to the 'more complex' ones.

Each block .tests a suitable selection of the possible operations, and must do two things: It has to make sure that the extra operations work, and it has to check that the 'unused' registers are not corrupted. I decided that the best way to achieve these was to use a standard machine-code subroutine, which would call the test segments proper one at a time.

Before each test, all the registers in the micro would be set to known values and, at the end of the test, they would all be saved in memory. The high-level, controlling, program (in BASIC) could then recover the stored data and test it for correctness before the next test.

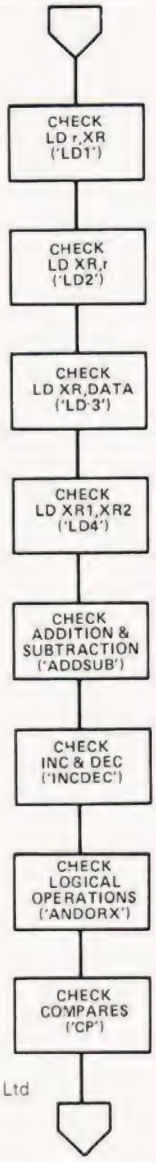


Fig.3. Flowchart for the checking operations to find out if your Z80 has the 'added-extra'.

Program 1 is an assembly-language listing for this controlling subroutine ('TSTALL'), and Program 2 shows the eight test segments. All are written to suit a TRS-80 (Level II, 16K). Each segment is fairly simple, but a few comments are probably in order.

TSTALL. This segment starts with a 'CALL 0A7FH', and ends with 'JP 0A9AH'. These are the TRS-80 routines which pass the value of HL between BASIC and machine-code, via USR — by using these, I did not have to use TSTALL to store HL in memory.

This segment also uses a 'CALL 7C45H' to get to each test segment; as we will see later, each is loaded, in turn, into the same area of RAM by the BASIC program. If the subsequent 'RET' goes wrong, then we know that SP has been corrupted by the tests.

ADDSUB. This segment tries each of the four eight-bit arithmetic operations once. I chose the values, and the sequence of using them, so that, as far as possible, multiple errors were unlikely to cancel each other out.

COMP. When we test the 'CP's, we have to make sure that the Z flag is set/reset at the right times. The 'LD's of A are arranged so that, if things go wrong, the segment exits with the wrong value in A.

Those, then, are the fundamental machine-code tests. To control them, however, I used a BASIC program, which made it much easier to assess the results and to format the output. The program has to do several things:

a. Load the appropriate machine-code segments.
b. Run the machine code.
c. Evaluate the results.
d. Output its assessment.

```
00100   ;ROUTINE TO CALL EACH TEST SEGMENT
00110   ;
00120   TSTALL  CALL 0A7FH          ;READ HL
00130           LD   A,75H          ;A = 75H
00140           LD   C,A
00150           LD   B,A            ;BC = 7575H
00160           LD   D,A
00170           LD   E,A            ;DE = 7575H
00180           CALL 7C45H          ;PERFORM TEST
00190           LD   (7C04H),BC     ;SAVE BC
00200           LD   (7C06H),DE     ;SAVE DE
00210           LD   (7C08H),IX     ;SAVE IX
00220           LD   (7C0AH),IY     ;SAVE IY
00230           LD   (7C02H),A      ;SAVE A
00240           JP   0A9AH          ;RETURN — PASS BACK HL
00250
```

Program 1 'TSTALL'

```
00260   ;TEST THE 'LD R,XR' INSTRUCTIONS
00270   ;
00280   LD1     LD   IX,1234H       ;IX = 1234H
00290           LD   IY,5678H       ;IY = 5678H
00300           LD   B,XL
00310           LD   C,YH           ;BC SHOULD = 3456H
00320           LD   D,YL
00330           LD   E,XH           ;DE SHOULD = 7812H
00340           LD   A,XH           ;A SHOULD = 34H
00350           RET
00360   ;
00370   ;TEST THE 'LD XR,R' INSTRUCTIONS
00380   ;
00390   LD2     LD   BC,2345H       ;BC = 2345H
00400           LD   DE,7890H       ;DE = 7890H
00410           LD   XH,C
00420           LD   XL,D           ;IX SHOULD = 4578H
00430           LD   YH,A
00440           LD   YL,E           ;IY SHOULD = 7590H
00450           RET
00460
```

```
00470   ;TEST THE 'LD XR,DATA' INSTRUCTIONS
00480   ;
00490   LD3     LD    IX,0          ;IX=0
00500           LD    IY,0          ;IY=0
00510           LD    XH,17H
00520           LD    XL,23H        ;IX SHOULD = 1723H
00530           LD    YH,0F0H
00540           LD    YL,8BH        ;IY SHOULD = 0F08BH
00550           RET
00560   ;
00570   ;TEST THE 'LD XR1,XR2' INSTRUCTIONS
00580   ;
00590   LD4     LD    IX,64H        ;IX=0064H
00600           LD    XH,XL         ;IX SHOULD = 6464H
00610           LD    IY,3700H
00620           LD    YL,YH         ;IY SHOULD = 3737H
00630           RET
00640   ;
00650   ;TEST THE ARITHMETIC INSTRUCTIONS
00660   ;
00670   ADDSUB  LD    A,90H         ;A=90H
00680           LD    IX,8020H      ;IX=8020H
00690           LD    IY,4030H      ;IY=4030H
00700           ADD   A,XH          ;SHOULD BE: A=10H, CY=1
00710           ADC   A,XL          ;SHOULD BE: A=31H, CY=0
00720           SUB   YH            ;SHOULD BE: A=0F1H, CY=1
00730           SBC   A,YL          ;SHOULD BE: A=0C0H
00740           RET
00750   ;
00760   ;TEST THE 'INC & DEC' INSTRUCTIONS
00770   ;
00780   INCDEC  LD    IX,0FFH       ;IX=00FFH
00790           LD    IY,0FF00H     ;IY=FF00H
00800           INC   XH
00810           INC   XH
00820           DEC   XL            ;IX SHOULD = 02FEH
00830           DEC   YH
00840           DEC   YH
00850           INC   YL            ;IY SHOULD = FD01H
00860           RET
00870   ;
00880   ;TEST THE 'LOGICAL' INSTRUCTIONS
00890   ;
00900   ANDORX  LD    IX,0B51CH     ;IX=0B51CH
00910           LD    IY,96D4H      ;IY=96D4H
00920           LD    A,0           ;A=0
00930           OR    XH            ;A SHOULD = B5H
00940           AND   YL            ;A SHOULD = 94H
00950           XOR   XL            ;A SHOULD = 88H
00960           RET
00970   ;
00980   ;TEST THE COMPARISONS
00990   ;
01000   COMP    LD    IX,1234H      ;IX=1234H
01010           LD    IY,5678H      ;IY=5678H
01020           LD    A,34H         ;A=34H
01030           CP    XH            ;A=XH?
01040           RET   Z             ;RETURN IF ERROR
01050           LD    A,56H         ;A=56H
01060           CP    YH            ;A=YH?
01070           RET   Z             ;SHOULD RETURN FROM HERE
01080           LD    A,10H         ;SET ERROR CODE
01090           RET                 ;ONLY HERE ON ERROR
01100           END
```

Program 2 Test Segments

```
10    REM TEST Z80 EXTRA INSTRUCTIONS
20    FL=-1: REM FL IS PASS/FAIL FLAG
30    CLS: PRINT @15, "TEST Z80 EXTRA INSTRUCTIONS":
40    POKE 16526,32:POKE 16527, 124:REM USR START POINT
50    FOR I=31776 TO 31809:READ B:POKE I,B:NEXT:REM LOAD TSTALL
60    REM START TESTING
70    FOR I=1 TO 8
80    READ IT,J1,J2,J3,J4,J5,F$:REM EXPECTED RESULTS AND CONTROL
      DATA
90    FOR I2=31813 TO 31812+IT:READ B:POKE I2,B:NEXT REM LOAD TEST
      SEGMENT
100   HL=USR (12345):REM RUN TEST
110   GOSUB 1000:REM RECOVER REGISTERS
120   IF A=J1 AND BC=J2 AND DE=J3 AND HL=12345 AND IX=J4 AND
      IY=J5 THEN GOSUB 2000 ELSE GOSUB 3000
130   NEXT I
140   IF FL THEN PRINT@841, "TESTS OF EXTRA INSTRUCTIONS
      SUCCESSFUL", ELSE PRINT@842, "TESTS OF EXTRA INSTUCTIONS
      FAILED",
150   END
1000  REM RECOVER REGISTERS
1010  REM A : 7C02H : 31746
1020  REM BC : 7C04H : 31748
1030  REM DE  7C06H . 31750
1040  REM IX . 7C08H : 31752
1050  REM IY . 7C0AH . 31754
1060  A=PEEK(31746)
1070  BC=256*PEEK(31749)+PEEK(31748)
1080  DE=256*PEEK(31751)+PEEK(31750)
1090  IX=256*PEEK(31753)+PEEK(31752)
1100  IY=256*PEEK(31755)+PEEK(31754)
1110  RETURN
2000  REM SUCCESS MESSAGE
2010  PRINT@I*64,F$;:PRINT@I*64+8,"SATISFACTORY".
2020  RETURN
3000  REM SUBROUTINE TO PRINT ERROR INFORMATION
3010  PRINT@I*64+32,F$;:PRINT@I*64+40,"FAILED",:FL=0:REM SET
      BASIC MESSAGE AND FLAG
3020  PRINT@640,"FAILURE REPORT FOR SEGMENT",F $
3030  PRINT "REGISTERS:"TAB(19)"A" TAB(24)"BC" TAB(31)"DE" TAB(38
      "HL" TAB(45)"IX" TAB(52)"IY"
3040  PRINT "SHOULD HAVE BEEN:" TAB(16)J1; TAB(22)J2, TAB(29)J3,
      TAB(36)12345; TAB(43)J4; TAB(50)J5
3050  PRINT "WERE:" TAB(17)A, TAB(22)BC; TAB(29)DE, TAB(36)HL,
      TAB(43)IX; TAB(50)IY
3060  PRINT@965, "PRESS 'A' TO ABANDON; PRESS 'C' TO CONTINUE".
3070  IN$=INKEY$: IF IN$="" THEN 3070
3080  IF IN$="A" END
3090  IF IN$="C" PRINT@640,STRING$(191," ");: PRINT@832,STRING$
      (191," ");:RETURN
3100  GOTO 3070
4000  REM CALLING ROUTINE
4010  DATA 205, 127, 10, 62, 117, 79, 71, 87, 95, 205, 69, 124, 237, 67, 4, 124
      237, 83
4020  DATA 6, 124, 221, 34, 8, 124, 253, 34, 10, 124, 50, 2, 124, 195, 154, 10
4030  REM LD1
4040  DATA 19, 52, 13398, 30738, 4660, 22136, LD1
4050  DATA 221, 33, 52, 18, 253, 33, 120, 86, 221, 69, 253, 76, 253, 85, 221, 125,
      201
4060  REM LD2
4070  DATA 15, 117, 9029, 30864, 17784, 30096, LD2
4080  DATA 1, 69, 35, 17, 144, 120, 221, 97, 221, 106, 253, 103, 253, 107, 201
4090  REM LD3
4100  DATA 21, 117, 30069, 30069, 5923, 61579, LD3
4110  DATA 221, 33, 0, 0, 253, 33, 0, 0, 221, 38, 23, 221, 46, 35, 253, 38, 240, 253,
      46, 139, 201
4120  REM LD4
4130  DATA 13, 117, 30069, 30069, 25700, 14135, LD4
4140  DATA 221, 33, 100, 0, 221, 101, 253, 33, 0, 55, 253, 108, 201
4150  REM ADDSUB
4160  DATA 19, 192, 30069, 30069, 32800, 16432, ADDSUB
4170  DATA 62, 144, 221, 33, 32, 128, 253, 33, 48, 64, 221, 132, 221, 141, 253,
      148, 253, 157, 201
4180  REM INCDEC
4190  DATA 21, 117, 30069, 30069, 766, 64769, INCDEC
4200  DATA 221, 33, 255, 0, 253, 33, 0, 255, 221, 36, 221, 36, 221, 45, 253, 37,
      253, 37, 253, 44, 201
4210  REM ANDORX
4220  DATA 17, 136, 30069, 30069, 46364, 38612, ANDORX
4230  DATA 221, 33, 28, 181, 253, 33, 212, 150, 62, 0, 221, 180, 253, 165, 221,
      173, 201
4240  REM COMP
4250  DATA 21, 86, 30069, 30069, 4660, 22136, COMP
4260  DATA 221, 33, 52, 18, 253, 33, 120, 86, 62, 52, 221, 188, 200, 62, 86, 253,
      188, 200, 62, 16,201
```

Program 3 Program listing for the BASIC controller

Program 3 is a listing of the program that I used.

Initially, the calling routine is loaded into the top of memory by a series of READs and POKEs, and then the tests proper start.

The first line of DATA for each test segment defines the number of bytes in the subroutine, the expected values in all the registers except HL (which should always be 12345), and the title of the segment. This data allows the test segment to be loaded and run.

The actual values of the registers, saved in memory by

'TSTALL', are recovered by the subroutine at lines 1000-1100, and the result is evaluated. If the results are OK, a suitable message is printed, and the program goes on to the next test.

If any failure occurs, the subroutine at line 3000 is called. This prints out an error message, and the expected and actual data in the registers. The routine also clears a flag (FL) to show that there was a fault. Finally, the fault routine sits in a loop while you make up your mind what to do next.

Figure 4 shows the sort of display which might appear partway through the test of a Z80 which does not respond properly. You'll notice that I have to modify the 'expected' values to force a failure. At the end of the test, a success/failure message appears.

The only other point to watch out for when you run this program on a TRS-80 is the protection of the RAM used for the machine-code. There's probably no threat to it, but you should answer the 'MEMORY SIZE?' prompt with 31734 to be safe.

Use On Other Micros

The program here runs on a TRS-80. What, you may ask, do you have to do to run it on, say an MZ-80K?

Obviously, the BASIC and the actual addresses used must be changed to suit the new machine. However, the critical parts of the program, the eight test segments, are all relocatable (they don't use absolute addresses), and so they shouldn't need any attention. You will have to massage 'TSTALL' a bit to suit how, or if, you pass the value of HL through a USR.

Conclusion

Most, if not all, Z80s have extra instructions in them which Zilog is very coy about. These instructions give the dedicated machine-code masochist four extra eight-bit general-purpose registers to play with, and can be very useful indeed.

It's very easy to test whether or not your micro has these commands. If it has, you've got an unexpected bonus, and if it hasn't — you never knew you were missing them.

```
                TEST Z80 EXTRA INSTRUCTIONS

LD1      SATISFACTORY
LD2      SATISFACTORY
                              LD3     FAILED
LD4      SATISFACTORY
ADDSUB SATISFACTORY
                              INCDEC FAILED

FAILURE REPORT FOR SEGMENT INCDEC
REGISTERS:  A     BC     DE     HL     IX     IY
SHOULD
HAVE BEEN: 117   32369  30069  12345  766    64769
WERE:      177   30069  30069  12345  766    64769

     PRESS 'A' TO ABANDON: PRESS 'C' TO CONTINUE
```

Fig 4. A typical failure output.

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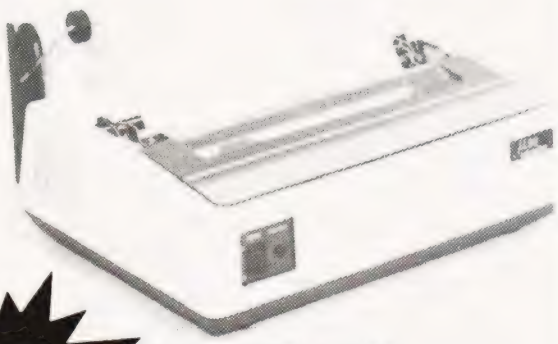

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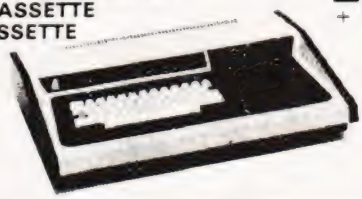

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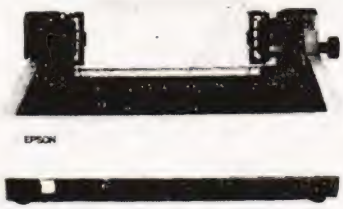

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Owen Bishop

Keep abreast of the time with our simple alarm clock unit and avoid those all-night programming sessions.

It happens every time! All micro enthusiasts know how ridiculously quickly time passes when one is engrossed in programming. A simple program that 'can be written in half-an-hour' always takes at least two or three hours to perfect! This can lead to all sorts of problems on the domestic scene. An alarm clock attached to the micro seems an ideal solution. Apart from this function it can be used by the system to give itself an alarm call and prompt it into some pre-arranged activity. Another use is to provide 'hardware' delays for periods up to 30 seconds.

The alarm clock is not an interface but an extension of the system. The micro sets the clock to cause an interrupt after a fixed period of time. With the circuit described here, it can set the alarm for any period up to four hours, in fifteen minute steps. It is easy to modify the design for other timings — even as long as a day or two. The block diagram (Fig.1) shows exactly what happens. The timing comes from a clock circuit generating pulses at approximately 2 Hz. These pulses are counted by a 14 stage CMOS counter. The set of outputs from the last four stages change at every 2048 th pulse (every 15 minutes). Four outputs are used, so it takes four hours to run from 0000 to 1111 and back to 0000.

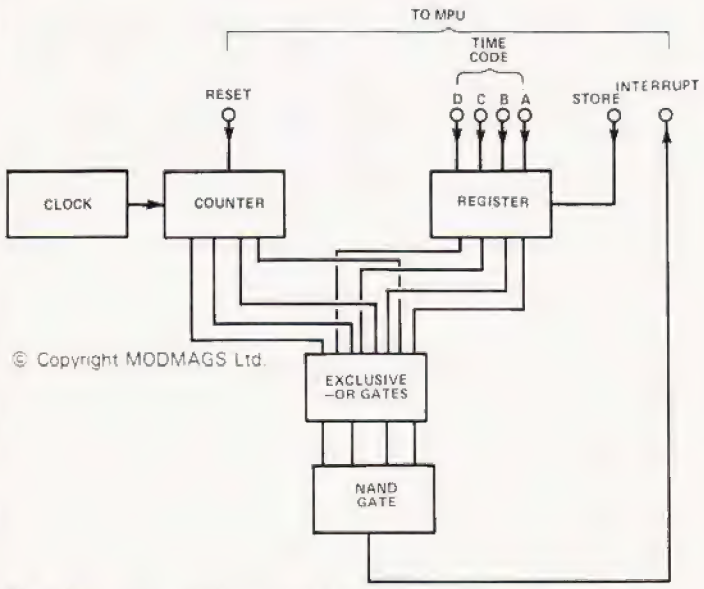


Fig.1. The clock unit block diagram.

Operating Sequence

To set the alarm clock, the required length of time is set onto the time code lines. The code is the number of quarter hour periods required, expressed in binary form. For example, half an hour (two quarters) is 0010, 3¼ hours (13 quarters) is 1101. In these codes A is the least significant digit. The code is registered when the CPU takes the normally high 'Store' input to low and back to high again. The inverse of the time code now appears on the output lines of the register, we are using the Q outputs. Next, a high pulse on the reset line makes all counter outputs go to zero. As soon as reset goes low again, the counter begins counting pulses from the clock. About 15 minutes later, output A (pin 15) goes high; A and the other three outputs count through from 0000 to 1111. Eventually a stage is reached at which the output from the counter is identical with the time code. Each exclusive-OR gate of IC3 is then receiving two inputs (remember the register is giving the *inverse* of the time code), so the output of every gate becomes high. Four high inputs to the NAND gate of IC5 forces its output to go low. This low output, if fed to the IRQ input of Acorn, causes an interrupt. If you are interfacing to the Mk-14 you will need to invert this output by using the spare gate of IC5 (dotted lines of Fig.2) to get a 'high-going' interrupt.

Interruptions

The micro is programmed to perform certain actions on being interrupted. If you are busily playing "Mastermind" at the time, it will leave you in suspense while it deals with these more important matters. First it registers how much time is to pass before the next interrupt and resets the clock. Next it performs a pre-arranged task, such as turning on the porch light. Finally, it returns to your game. A possible daily sequence is illustrated in Table 1. The 'nil action' interrupts allow periods longer than four hours to be bridged. Items such as coffee pots and electric blankets can be turned on by the micro, but switched off by the user at a convenient time. In

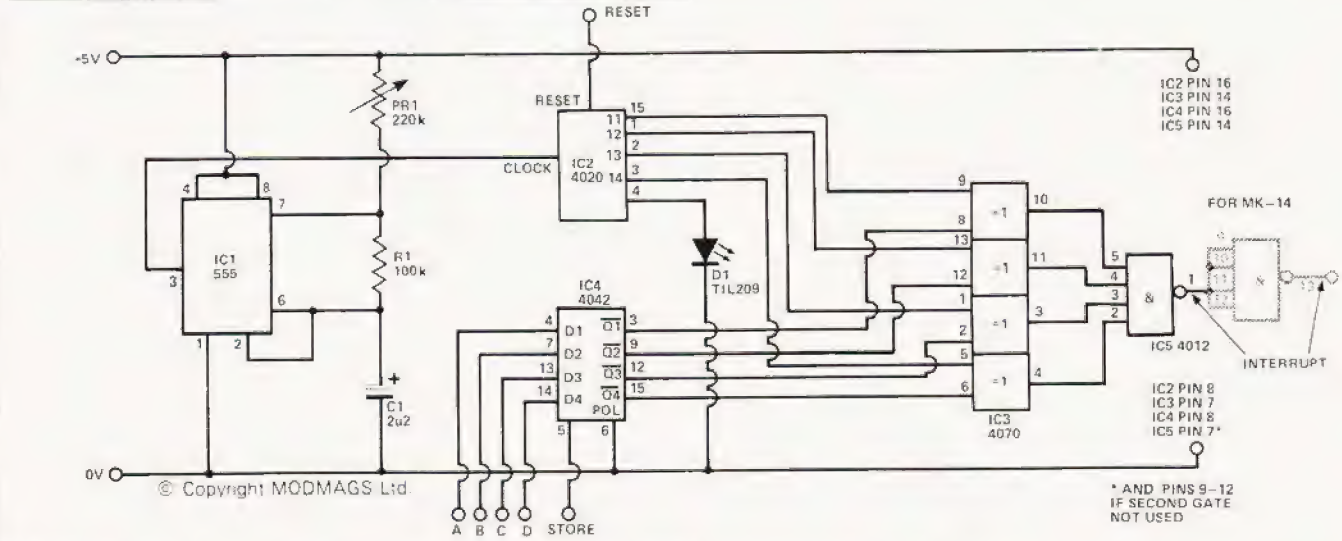


Fig.2. Circuit diagram for the clock. Note that the shaded area on the right is for the Mk-14 only.

between all these activities the micro can be fully occupied with 'Mastermind' and a host of other tasks — provided that the interrupt programs are not lost in the process.

Another entirely different use for the clock is for timing moves in games. For this the timing periods could be reduced by using a capacitor of smaller value. The game could be interrupted if a player has made no move in, say, five minutes. Or the clock could be used in projects such as counting the number of vehicles passing along a road during quarter hour periods throughout the day.

Construction

First build the clock circuit (IC1) and test it to make certain that it is working. If the positive probe of a test meter is applied to pin 3, the needle should flick regularly about twice a second. Next construct the counter circuit (IC2) and connect it to the clock output. With the reset input low, pulses at 1 Hz should be coming from pin 9. The LED, D1, should turn on and off every 30 S (approx). To adjust the clock to run with exactly quarter hour periods, PR1 is set so that the interval between successive off-on periods of D1 is exactly 28.125 S (or 3 mins 45 S for eight periods). The remainder of the construction presents few problems except those of following the wiring diagram correctly, making sure all solder joints are good, and

Table 1. A typical daily routine.

Interrupt time	Time set for next call (hours)	Other action
0200	4	Nil
0600	1	Switch on house heating
0700	½	Wake family
0730	1	Display list of day's events
0830	2	Reduce house heating temperature
1030	4	Switch on coffee pot
1430	1	Nil
1530	½	Begin tape-recording radio
1600	1	Tape recorder off
1700	1	Increase house heating temperature
1800	3	Porch light on
2100	1	Electric blanket on
2200	1	Switch house heating off Test intruder-detector system
2300	3	Porch lighting off

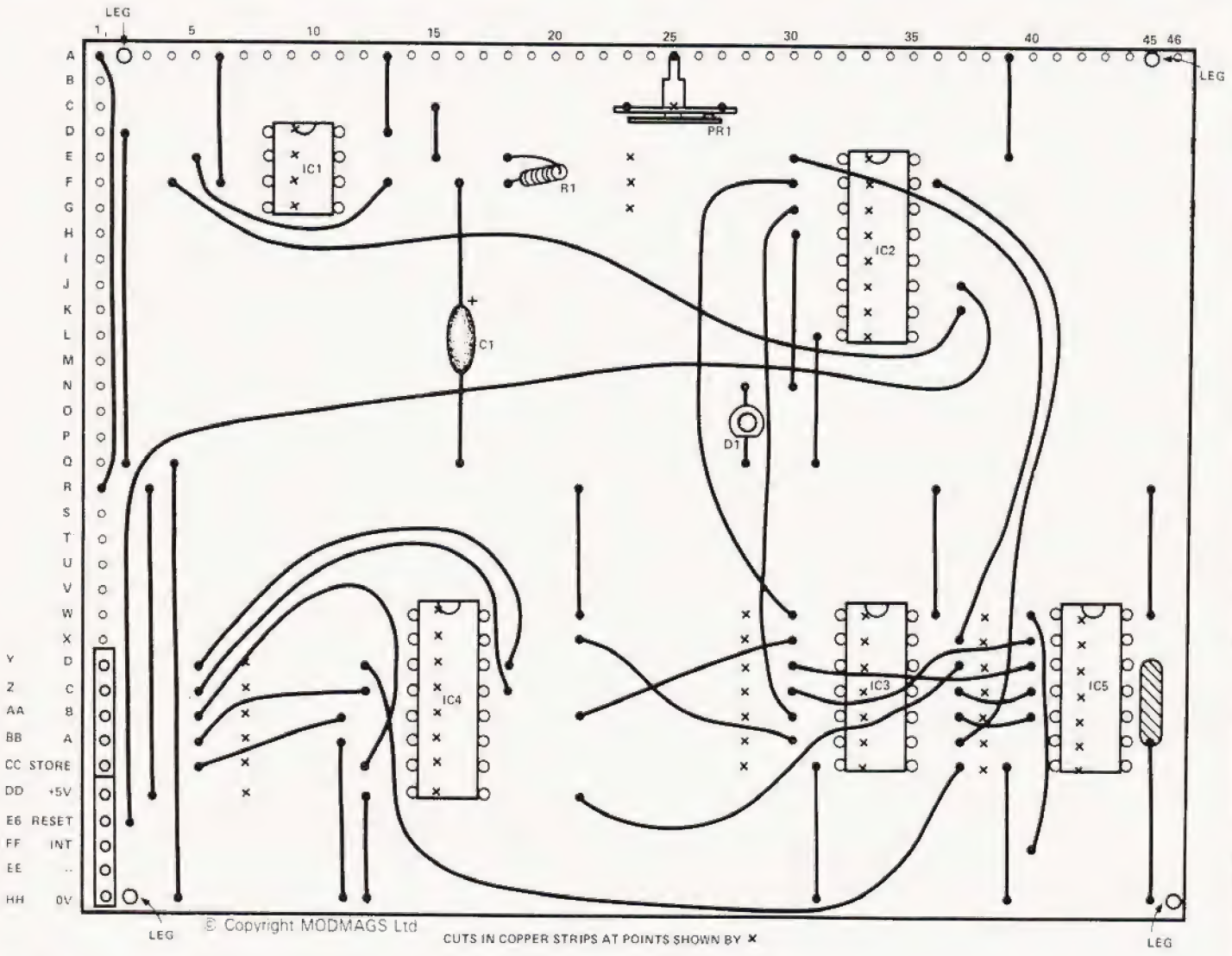


Fig.3. Overlay for the circuit on Veroboard.

that there are no unintentional short-circuits (especially incompletely cut strips and stray threads of solder). If you are interfacing to Mk-14, omit the wires joining W41-FF41 and BB45-HH45. Run a wire from W41 to Y45, and another from BB45 to FF45.

The board is connected to the micro by the PCB plugs and sockets used in previous projects in this series. The circuit is powered from the 5 V supply of the system and operates through Port B of the input/output device. The plugs have almost the same connections as used for Thermoface (CT July 1980) and the digital to analogue interface (CT August 1980), so the same connecting links can be used. As can be seen from Figs. 5 and 6, the only modification is that one line goes to the interrupt input, instead of to Port B1 as in the previous interfaces. For Acorn, it is better to use the interrupt request (IRQ) input rather than non-maskable interrupt (NMI). This leaves NMI free to receive interrupts from devices with higher priority, such as intruder-alarms and fire-detectors. The topic of interrupts was dealt with fully in CT October 1980 so we will not go into details here.

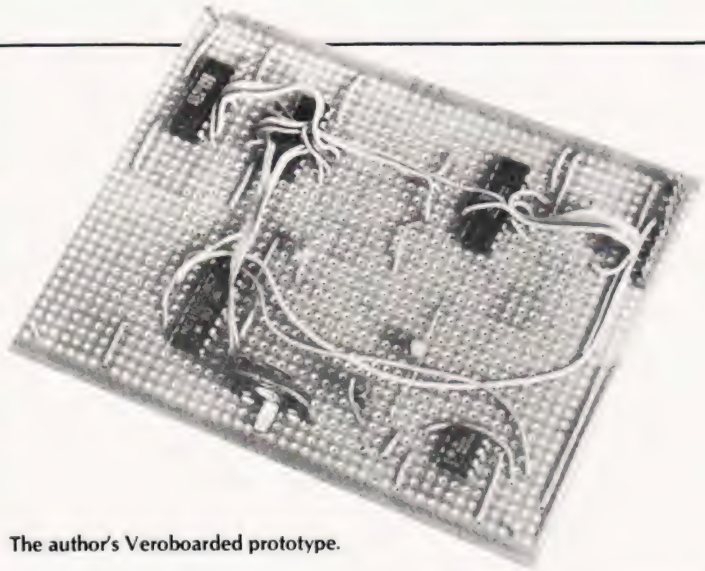
Program

The time code occupies the upper four bits of Port B; Store and Reset are the most significant bits. The sequence for setting the alarm is as follows, the example in the right-hand column showing (in binary and hexadecimal) the byte required to set the alarm for a 1½ hour period.

Step	Action	Function	Port B outputs (Example)
1	Send time code: Store low: Reset low	Time code appears on register	0110 0000 = 60
2	Send time code: Store high: Reset low	Time code latched	0110 1000 = 68
3	Reset high: Store high	Resets counter	0000 1100 = 0C
4	Reset low: Store high	Timing begins	0000 1000 = 08

Modifications

The time-scale can be made longer or shorter by using a capacitor of different value for C1. If finer control of the timing is required, additional ICs can be run in parallel with IC3 and IC4. This provides an eight-bit time code. Reset and Store can then be controlled through Port A. The additional



The author's Veroboarded prototype.

exclusive-OR gates are fed from the 10, 9, 8 and 7 outputs of IC2 (pins 14, 13, 12 and 6 respectively). This allows times up to four hours to be set with an accuracy of one minute. If PR1 is adjusted so that output '7' gives exact minutes, the total run takes four hours and 16 minutes (256 minutes).

For this modification, IC5 will be an eight-input NAND (4068). A much simpler modification makes use of the spare port, B0, and the pin at GG1. This could be wired either to the clock (IC1) output or to one of the lower outputs of IC2. If the clock has a period of 0.5 S, pins 9,7 and 5 have periods of 1,8 and 16 S, respectively. One of these outputs can be used to provide delays that are longer than can be conveniently provided by software. Note that the outputs of IC2 have a 50% duty cycle, but that of the clock does not.

PARTS LIST

Resistors	
R1	100k Hi-Stab
PR1	220k Cermet
Capacitors	
C1	2u2 tantalum
Semiconductors	
IC1	555
IC2	4020
IC3	4070
IC4	4042
IC5	4012

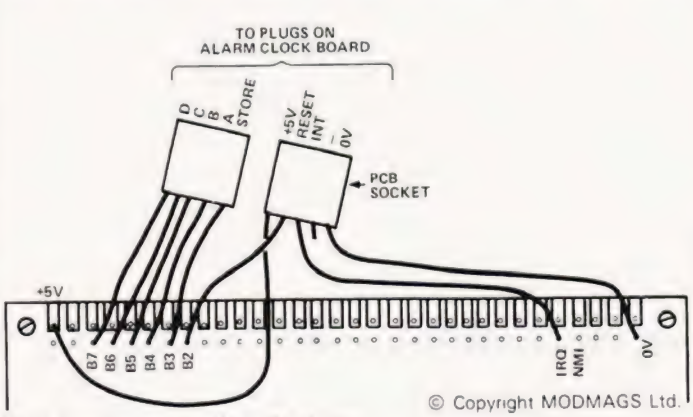


Fig.4. How to connect it to the Acorn.

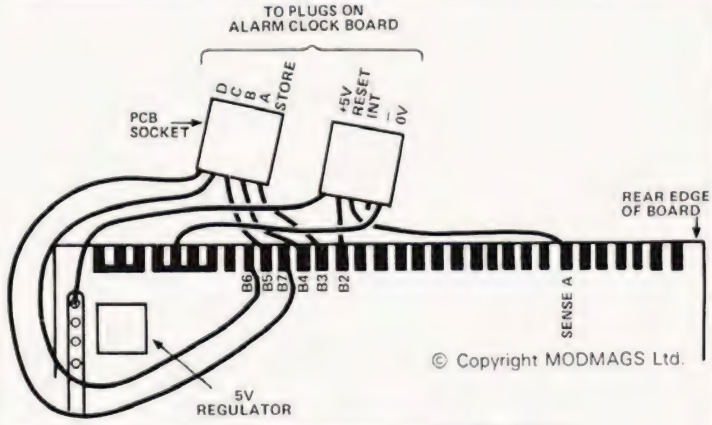


Fig.5. Same plugs but different connections for the Mk-14.

Programs For Mk-14

Main Program (Sets up Interrupt pre-conditions, and sets I/O to control the alarm clock)

```
0F20   C4 0F   LDI   'OF'  ]
0F22   37      XPAH  P3    ] P3 to interrupt routine -1
0F23   C4 4F   LDI   '4F'  ]
0F25   33      XPAL  P3    ]
0F26   C4 08   LDI   '08'  ] Set interrupt enable
0F28   07      CAS         ]
0F29   C4 0A   LDI   'OA'  ]
0F28   35      XPAH  P1    ] P1 set to I/O
0F2C   C4 00   LDI   '00'  ] device (0A00)
0F2E   31      XPAL  P1    ]
0F2F   C4 FC   LDI   'FC'  ] Ports 82-87 defined
0F31   C9 23   ST    P1+23 ] as outputs
```

The above segment needs to be listed once only. P1 and P3 must not be reset to other addresses. Remember to keep 'interrupt enable' high if CAS is used elsewhere in the program.

Alarm setting program (MPU jumps to this at interrupt)

```
0F50   C4 60   LDI   '60'        ]
0F52   C9 21   ST at Port B      ] Time code (1½ hours)
0F54   C4 68   LDI   '68'        ]
0F56   C9 21   ST at Port B      ] Time code latched
0F58   C4 0C   LDI   'OC'        ]
0F5A   C9 21   ST at Port B      ] Reset
0F5C   C4 08   LDI   '08'        ]
0F5E   C9 21   ST at Port B      ] Begin timing at interrupt
```

— followed by program for any further action at interrupt. If a sequence of interrupts is programmed, this action can include altering contents of 0F51 and 0F55, to give a different setting for the alarm at the next interrupt.

Programs For Acorn

Main Program (Sets up IRQ pre-conditions, and sets I/O to control alarm clock)

```
001E   00                        address of IRQ
001F   02                        routine (0200)
0020   58      CLI               allows interrupts
0021   A9 FC   LDA   'FC'        Port B2-B7 defined
0023   8D 2309 STA   ODB         as outputs
```

The above segment needs to be listed once only.

The corresponding alarm setting program is,

```
0200   A9 60   LDA   '60'          ]
0202   8D 2109 STA at Port B       ] Time code 1½ hours
0205   A9 68   LDA   '68'          ]
0207   8D 2109 STA at Port B       ] Time code latched
020A   A9 0C   LDA   '0C'          ]
020C   8D 2109 STA at Port B       ] Reset
020F   A9 08   LDA   '08'          ]
0211   8D 2109 STA at Port B       ] Begin timing
```

— followed by program for any further action at interrupt. If a sequence of interrupts is programmed, this action can include altering the contents of 0201 and 0206, to give a different setting for the alarm at the next interrupt. Finish the program with another CLI instruction ('58') to reset the interrupt-enable flag.

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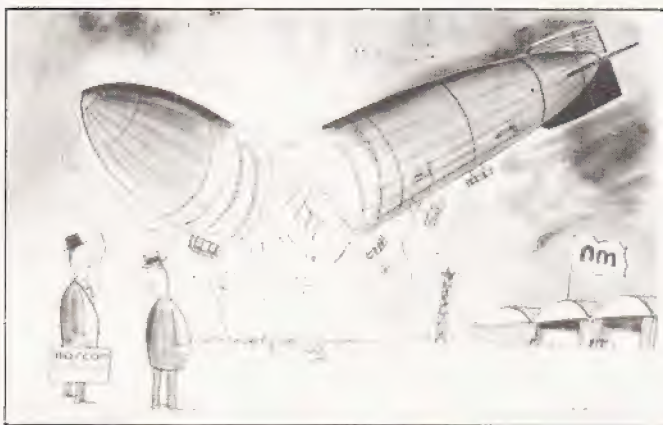
Peter Mathews Chairman



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MEMORY TEST

Kevin Townsend

Memory Test is a simple program for PET owners, or those with other micros that support sound boxes. The game is a version of the 'Simon' toy in that you have to remember an increasing sequence of numbers and their associated tones.

All the instructions are included in the program and the characters within square brackets are to the usual CT standards. Connections to a soundbox are from the N and M pins on the user port, a simple amplifier will suffice.

Program Listing

```
  1 REM**MEMORY TEST
  4 CLR
  5 PRINT" [CLS ]MEMORY TEST"
  6 S1=59464:S2=59466:S3=59467
  8 PRINT"   = = = = = =  = = = ="
 10 PRINT"THE IDEA OF THIS GAME IS TO
    REPRODUCE"
 20 PRINT"THE SERIES OF NUMBERS I WILL
    PRINT FOR"
 30 PRINT"YOU."
 40 PRINT"IF YOU MAKE A MISTAKE PRESS
    'HOME' & TRY"
 45 PRINT"AGAIN, OR PRESS 'DEL' TO DELETE
    LAST GO."
 50 PRINT"PRESS 'E' TO END."
 60 PRINT"DO YOU REQUIRE SOUND? (Y/N) ";
 61 GET A$
 62 NU=RND(TI):REM**RANDOMISE
 63 IF A$=" "THEN 61
 70 IF A$="N" THEN POKE S3,0:GOTO 77
 75 IF A$="Y" THEN POKE S3,16:GOTO 77
 76 GOTO 61
 77 PRINT A$
 79 INPUT"RATE OF CHANGE OF SEQUENCE
    LENGTH";R
 80 INPUT"MAXIMUM SEQUENCE LENGTH?";S
 83 IF S>80 THEN S=R-1:REM ** 80 IS MAX FOR
    8K PET
 85 IF S<R THEN PRINT"ERROR, SEQUENCE
    LENGTH(";R;"TO 80)";:INPUT S:GOTO 83
 94 PRINT"GOOD LUCK!":FOR Q=1 TO 700:NEXT
 95 REM**PICK SEQUENCE & STORE
 99 DIM N(S+2),M(S+2)
100 FOR A=1 TO S
150 N(A)=INT(10*RND(TI))
200 NEXT
300 G=0
350 REM**MAIN PRINTING ROUTINE
400 G=G+R
410 IF G>S THEN G=S
450 PRINT" [CLS ] [8 CD ]";
500 FOR A=1 TO G
530 POKE S2,15:POKE S1,150-N(A)*10
550 PRINT N(A)" ";
555 FOR X=1 TO 100:NEXT:POKE S1,0
560 IF A/10=INT(A/10)THEN PRINT" ";
600 NEXT
650 PRINT" [HOM ]YOU HAVE ";INT(G/2);"
    SECONDS TO MEMORISE THE SEQUENCE";
651 PRINT". . . . . ";G;"NUMBERS"
700 FOR Q=1 TO 450*G:NEXT
730 REM**YOUR REPLY
740 POKE S1,70:FOR P=1 TO 100:NEXT:POKE S1,0
750 PRINT" [CLS ]O.K. NOW RETYPE THE
    SEQUENCE"
753 FOR K=1 TO 10:GET W$:NEXT
755 REM**SOAK UP EXTRA KEY PRESSES
780 PRINT" [HOM ] [8 CD ]";:FOR C=1 TO G:
    PRINT" [↑$ ] ";:IF C/10=INT(C/10) THEN
    PRINT" ";
790 NEXT
795 PRINT" [HOM ] [8 CD ]";
800 FOR A=1 TO G
810 FOR U=1 TO 100:NEXT
830 POKE S1,0
850 GET A$:IF A$=" "THEN 850
855 B=VAL(A$)
860 IF A$=" [HOM ]"THEN PRINT" [CLS ]TRY
    AGAIN":POKE S1,0:FOR K=1 TO 1000:NEXT:
    GOTO 750
862 POKE S2,15:POKE S1,150-10*B
863 IF A<=2 THEN GOTO 868
865 IF A$=CHR$(20)THEN A=A-1:PRINT" [3 CL ]
    [↑$ ] [2 CL ]";
867 IF A$=CHR$(20)AND(A-1)/10=INT
    ((A-1)/10) THEN PRINT" [CU ]";
868 IF A$=CHR$(20)THEN 810
869 IF A$="E" THEN POKE 59467,0:END
873 PRINT B;" ";
875 REM**PRINT IN ROWS OF TEN
876 IF A=0 THEN 880
877 IF A/10=INT(A/10)THEN PRINT" [CD ]";
880 M(A)=B
900 NEXT A
910 POKE S1,0
950 REM**CHECK FOR ERRORS
999 ER=0
1000 FOR A=1 TO G
1010 IF N(A)<>M(A) THEN ER=ER+1
1050 NEXT
1100 IF ER>0 THEN GOTO 1500
1130 IF S>G THEN GOTO 1150
1140 GOTO 5000
1145 REM**CORRECT REPLY
1150 PRINT" [CLS ]CORRECT      TRY A LONGER
    SEQUENCE"
1155 REM**TONE FOR CORRECT REPLY
1156 POKE S2,15:POKE S1,50:FOR Z=1 TO 20:POKE
    S1,50
1160 FOR X=1 TO 80:NEXT:POKE S1,100:NEXT:
    POKE S1,0:GOTO 400
1460 REM**INCORRECT REPLY
```

```
1500 PRINT" [CLS ]WRONG, YOU MADE";ER;
     "MISTAKES, TRY AGAIN"
1520 REM**TONE FOR INCORRECT REPLY
1530 POKE S2,15:POKE S1,200:FOR Q=1 TO 12:
     POKE 59464,230
1550 FOR U=1 TO 35:NEXT:POKE 59464,180:NEXT:
     G=G-R:GOTO 400
2000 T=TI:IF TI=T+60*G THEN NEXT
4200 REM**TOTAL SEQUENCE
5000 PRINT" [CLS ] [7 CD ]      FANTASTIC!"
5010 PRINT"YOU MADE YOUR SEQUENCE OF";
     INT(S);"NUMBERS"
5050 FOR H=1 TO 7
5060 FOR J=200 TO 10 STEP -10
5080 POKE S1,J/2
5100 NEXT:NEXT
5150 REM**POKE 59467,0 TO REACTIVATE
     CASSETTE
5200 POKE 59464,0
5500 PRINT"ANOTHER GAME?";
5510 GET A$:IF A$=" "THEN 5510
5515 PRINT A$
5520 IF A$="Y" THEN 1
5530 IF A$="N" THEN POKE 59467,0:END
5555 GOTO 5500
63999 END
```

ZX80 RE-NUMBER

A. Beasley

After using the ZX80 for a few months I found that there was a need for a simple renumbering program. In the attempt to solve the problem a BASIC program was written out but this took far too much memory space. Whilst machine code was the obvious solution it did raise yet another problem. How could the program be stored so that it could be used without any trouble? After attempting to store it in a REM line it was found that some of the codes made the system crash when the program was listed.

Solutions

To get over the problem the following method was developed. First all the variables are CLEARed. A string variable is now set up to contain the required number of bytes and the machine code is POKEd into it. As this string variable is the first in the list its location can be found from the two bytes called VARS, see page 122 in the manual. By adding one to the value obtained you have the location of the first character in the string. To call the program you simply find the value of VARS, add one and use this number as a USR call.

More Problems

This method generates its own set of problems however. If you are using it for program operation you cannot use the following commands, RUN, CLEAR or NEW. By using GOTO you can get over the RUN problem and the others are not really drastic.

The main advantage of this method is that when you save the program you still preserve the string for the next time. It should be noted that the GOTO and GOSUB statements are not altered but you do get everything into 35 bytes.

Operation

To use the program type in with Z$ containing 33 characters. Now run the program then remove it by typing just the line numbers and then 'Newline'. The program you wish to renumber can be keyed in but remember not to use the RUN or CLEAR keys and make sure that the program does not contain Z$.

To activate the renumber type PRINT USR (1+PEEK(16392)+PEEK(16393)*256).

```
1   CLEAR
2   LET Z$="aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa"
3   LET A$="06000E0A2128407023713E0A814F300404
    CB70C0237EFE7620FA237ECB7FC018E6"
4   LET A=1+PEEK(16392)+PEEK(16393*256)
5   FOR C=1 TO 33
6   LET B=CODE (A$)-28
7   LET B=B*16
8   LET A$=TI$(A$)
9   LET B=B+CODE(A$)-28
10  LET A$=TI$(A$)
11  POKE A,B
12  LET A=A+1
13  NEXT C
```

MEMORY MAP

G. Elkin

The following is a list of important addresses for the TRS 80 which may prove useful to those of you who are just starting with the machine. The list cannot be considered complete but it does provide a useful 'quick guide' to the most commonly used information.

Information	Decimal	Hex
Level II BASIC***	00000-12287	0000-2999
Memory mapped I/O	12288-16383	3000-3FFF
Communication status	14302	37DE
Communication data	14303	37DF
Interrupt latch	14304	37E0
Disc drive select latch	14305	37E1
Cassette select latch	14308	37E4
Line printer	14312	37E8
Floppy disc controller	14316	37EC
Keyboard	14336-14591	3800-38FF
VDU (16 lines of 64)	15360-16383	3C00-3FFF
BASIC vectors (RST 1-7)	16384-16404	4000-4014
Keyboard disable*	16405	4015
Driver (LSB,MSB)	16406,16407	4016,4017
Zero	16408-16410	4018-401A
'K' (code 75)	16411	401B
'I' (code 73)	16412	401C
VDU disable*	16413	401D
Driver (LSB,MSB)	16414,16415	401E,401F
Cursor position (LSB,MSB)	16416,16417	4020,4021
Cursor character	16418	4022
'D' (code 68)	16419	4023
'O' (code 79)	16420	4024
Printer disable	16421	4025
Driver (LSB,MSB)	16422,16423	4026,4027
Lines/page**	16424	4028
Line counter	16425	4029
Zero	16426	402A
'P' (code 80)	16427	402B
'R' (code 82)	16428	402C
Disc interrupt vector	16464	4050
Communications interrupt vector	16466	4052
25 mS interrupt vector	16478	405E
USR (x) start (LSB,MSB)	16526,16527	408D,408E
BASIC program start (LSB,MSB)	16548,16549	40A4,40A5
Memory end (LSB,MSB)	16561,16562	40B1,40B2
First line number (LSB,MSB)	16633,16634	40F9,40FA
BASIC instruction table	16722-16805	4152-41A5
OPEN	16761-16763	4179-417B
CLOSE	16773-16775	4185-4187
RSET	16794-16796	419A-419C

Notes:

* Level II = 0, Disc = 16, Normal = 1

** 66 on power-up.

*** Level I BASIC ends at 4095, 0FFFH

Those with a desire to learn more are recommended to read 'Machine language programming from the ground up' by Hubert Howe which is available from A J Harding (Molimerx) Ltd.

SCREEN SCROLL

P. Leveridge

The following routine will enable the NASCOM 1 to only scroll the bottom four lines of the screen, whilst the rest remains stationary.

To use this routine, its address must first be put into the reflection table at 0C4A. This can be done using the M command. Both bytes must be put on the same line in the M command otherwise disaster will result since the M command also uses the reflection. Any number of lines can be scrolled by changing the values of HL, DE, BC at addresses 0C5E-0C63. This is very useful if it is patched into Tiny BASIC (or any other sort), because it enables the user to keep a set of axes on the screen whilst reading in values to be plotted. This gives the NASCOM the 'GRAPH' command as on the Research Machines 380Z. This was written for B-Bug but should work on any monitor, except that the monitor reflection addresses will be different.

```
0C50 FE 1F     START:CP A, 1FH          ;Is it a carriage return?
0C52 C2 3B 01        JP NZ,CRT          ;No, output character
0C55 F5 C5 D5 E5     PUSH AF, BC, DE, HL ;Save all the registers
0C59 2A 18 0C        LD HL, CURPOS      ;Point HL at cursor address
0C5C 36 20           LD (HL)," "        ;Blank the cursor
0C5E 11 CA 0A        LD DE, 0ACAH       ;Set up for half scroll
0C60 21 0A 0B        LD HL, 0B0AH       ;
0C63 01 B0 00        LD BC, 0B00H       ;
0C66 C3 9E 01        JP 19EH            ;Jump into middle of monitor
                                        routine
```

TWO TONE

S J Stamps

This simple modification allows inverted video to be displayed on the NASCOM 1. The connections shown in Fig. 1 are made as follows. Pin 9 of IC 15 is bent out from its socket and a small piece of wire is inserted in its place. Connection to the pin is made by soldering directly to the IC leg and this is then taken to the inverter gate which can be made from any 'spare' logic element. The four options can be selected by wire links or by a DIP switch or, by the more adventurous, with a 74126 and the output port.

The options give the following result:

XA Normal
XB Inverted Black on White
XC Black Screen
XD White Screen.

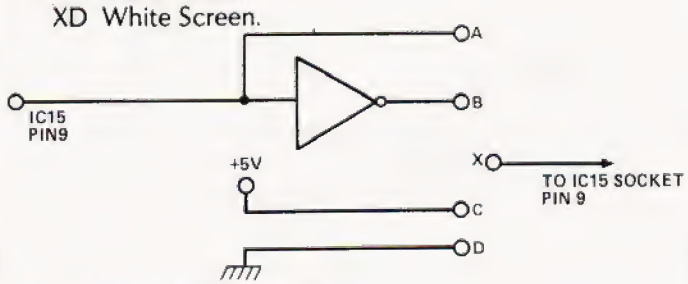

Fig. 1. The simple circuit modification.

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REACT O'TIME

Syd Arkless

The idea for this program evolved out of a desire to incorporate the knowledge I had acquired in writing two previous programs, one concerned almost exclusively with writing text onto the screen, the second, a digital 24 hour clock. I wished to combine these two and also investigate two new techniques, namely, generating random numbers (and turning these into predetermined characters) and also to have some interaction between the keyboard and microprocessor during program execution.

Initial Concept

The basic idea was to produce a random number, turn this into a character, start a clock and stop it when the correct character was pressed on the keyboard, a basic reaction timing game.

With this thought in mind it was decided to incorporate two specific features into the program, namely, a continuous screen display of the best time so far, which would automatically be changed whenever it was bettered, and a facility to record the name of the person obtaining the current best time which could only be altered when a better time was obtained. In an earlier attempt at this program only the characters 0 to 9 were generated but an astute lady soon discovered that if she hovered over one key that this would, sooner or later, appear and the best times that she recorded (while I wasn't looking) were definitely unbeatable! It was therefore decided to include the generation of the alphabet as well as the numerals. Finally a 'cheat' routine was included to catch any attempt by the 'trigger happy' to anticipate the character before it actually appeared.

The Program

The program is designed to run on a standard NASCOM incorporating B-BUG monitor as the only addition. I'm afraid I succumbed to this as the loading and dumping times of the standard monitor were becoming very tedious.

0C50 - 0C96	clears the screen and generates the text.
0C97 - 0CAF	generates a random character and after a delay prints it on the screen and also checks whether a key has been pressed in anticipation of the character in which case the program goes to a cheat routine at 0D52.
0CB0 - 0CDA	prints the random character on screen, provides a 1/100th S (approx) delay and checks whether a character has been pressed on the keyboard.
0CDB - 0D10	this is the four digit 1/100th S clock
0D10 - 0D13	compares the character pressed with the character generated and if there is no compare returns to the clock.
0D14 - 0D47	test the new time against the previous best time and if it is better jumps to an exchange routine at 0DC4 if not it jumps to the restart routine at 0D92.
0D48 - 0D51	Print sub-routine.
0D52 - 0D66	Cheat sub-routine which generates the cheat text and imposes a time of 10:00 S on the clock as a penalty before continuing to the restart routine.
0D92 - 0DC3	Restart routine which generates on screen instructions and after receiving instructions from the keyboard clears its text, and clears the generated character from the screen before jumping to 0E B6 which resets the clock time to 00:00 and returns the program to 0C97.

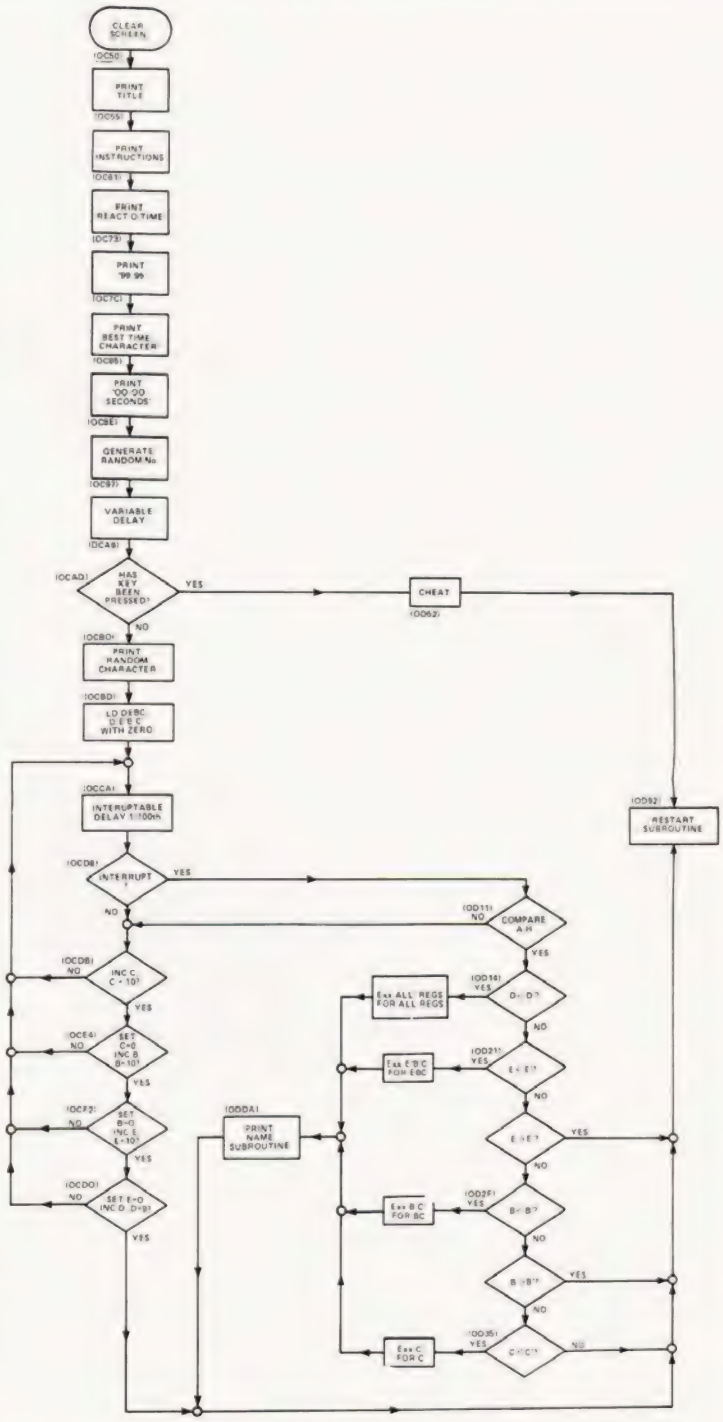

Fig.1. Flowchart for the complete program.

0DC4 - 0DDB	Exchange sub-routine which exchanges best time for the clock if necessary.
0DDC - 0E0D	Print Name routine allows a new name to be printed beneath 'best time' when required.
0E20 - 0EB4	Search Table which provides a keyboard character from the random number.
0EB5	Workspace for the random number generator contained in B-BUG.
0F00 - 0FE9	Main text storage.

Using The Program

The program is executed from 0C50 and will display the title, instructions, the clock set to 00:00, the best time set to 99:99 and the character space (empty). After a few seconds a character will appear in the character space and the clock is started. When the same character is pressed on the keyboard the clock is stopped and the time displayed compared with the best time. Pressing an incorrect character will have no effect. If the new time is better than the previous best time this will automatically be substituted and the instruction 'PRINT NAME' occurs beneath the new best time. The name may now be printed using the keyboard, before commencing the name a 'space' should be entered to allow space for the cursor to be returned at the end of printing. There are 15 characters allowed for the name and all must be used, spaces being used at the end of the name until the stationary cursor position is reached. This will then initiate the restart routine and 'R for restart' will be printed at the bottom of the screen. In fact pressing any key will clear both clock and character but leave the best time and name unaltered. If an attempt is made to anticipate and a key is pressed before a character appears the following text will appear, 'You anticipated and cheated your penalty is: 10:00 seconds' and 'R for Restart'. Note that the 10 S penalty following a cheat can *never* be exchanged for the best time. If the current time is not less than the best time then 'R for restart' appears immediately.

```
Clear Screen
0C50   3E 1E          LD A, 3E
0C52   CD 3B 01       CALL CRT        ;clear screen

Print 'REACT 0' TIME'
0C55   DD 21 DA 0B    LD IX, 0BDA     ;screen start (top line)
0C59   21 00 0F       LD HL, 0F00     ;text start address
0C5C   06 0D          LD B, 0D        ;no. of text
                                      chars.(13D)
0C5E   CD 48 0D       CALL PRINT      ;Call print sub-routine

Print 'When a character appears on the screen'
0C61   DD 21 4E 08    LD IX, 084E     ;screen start address
0C65   06 26          LD B, 26        ;no. of chars. (38D)
0C67   CD 48 0D       CALL PRINT      :call print sub-routine

Print 'press the SAME character on the keyboard'
0C6A   DD 21 8E 08    LD IX, 088E     ;screen start address
0C6E   06 29          LD B, 29        ;no. of chars. (41D)
0C70   CD 48 0D       CALL PRINT      ;call print sub-routine

Print 'YOUR REACTION TIME IS.
0C73   DD 21 16 09    LD IX, 0916     ;screen start address
0C77   06 19          LD B, 19        ;no. of chars. (25D)
0C79   CD 48 0D       CALL PRINT      ;call print sub-routine

Print '99:99'
0C7C   DD 21 4E 0B    LD IX, 0B4E     ;screen start address
```

```
REACT O' TIME

When a character appears on the screen
press the SAME character on the keyboard.

YOUR REACTION TIME IS . . . .

02:04 seconds
BEST TIME                    CHARACTER

  02:04                          J
_R. WATERBRIDGE   _R FOR RESTART
```

A typical screen display from the game.
The best time has just been beaten.

```
0C8C   06 05          LD B, 05        ;no. of chars. (05D)
0C82   CD 48 0D       CALL PRINT      ;call print sub routine

Print 'BEST TIME.....CHARACTER'
0C85   DD 21 CB 0A    LD IX, 0ACB     ;screen start address
0C89   06 2D          LD B, 2D        no. of chars. (44D)
0C8B   CD 48 0D       CALL PRINT      ;call print sub-routine

Print '00:00  seconds'
0C8E   DD 21 1B 0A    LD IX, 0A1B     ;screen start address
0C92   06 0E          LD B, 0E        ;no of chars. (14D)
0C94   CD 48 0D       CALL PRINT      ;call print sub-routine

Generate Random character
0C97   21 B5 0E       LD HL, 0EB5     workspace for R.N.G
0C9A   3E 24          LD A, 24        max random no.(36D)
0C9C   CD 7A 04       CALL R.N.G.     ;call random number
                                      generator
0C9F   21 20 0E       LD HL, 0E20     ;search table address
0CA2   CD 66 04       CALL SEARCH     ;call search sub
                                      routine
0CA5   7E             LD A, (HL)      ;loads the char. into
                                      Acc.

Variable delay and test for keyboard pressed too soon (cheat)
0CA6   16 01          LD D, 01        ;fixed delay value
0CA8   5F             LD E, A         ;loads char. for
                                      variable del.
0CA9   F5             PUSH AF         ;saves char. in A
0CAA   CD B9 04       CALL I.DEL      ;sets carry if
                                      keyboard pressed
0CAD   DA 52 0D       JMP. C          ;jmp. to 'CHEAT'
                                      routine.
Print the character generated
0CB0   F1             POP AF          ;retrieve char. value
                                      in A
0CB1   21 72 0B       LD HL, 0B72     ;screen address
0CB4   77             LD (HL), A      ;print char on screen

Load index registers with clock screen positions
0CB5   DD 21 1B 0A    LD IX, 0A1B     ;screen pos. for D
0CB9   FD 21 4E 0B    LD IY, 0B4E     ;screen pos. for D'
```

```
Load registers BCDE,B'C'D'E' with zeros 00:00
0CBD  16 30        LD D, 30        ,30H = OD ASCII
0CBF  5A           LD E, D         ,load E with
                                   30H = OD ASCII
0CC0  42           LD B, D         ,load B with
                                   30H = OD ASCII
0CC1  4A           LD C, D         ;load C with
                                   30H = OD ASCII
0CC2  D9           ExxHL, H'L'     ;exx  regs, save DEBC
0CC3  16 30        LD D, 30        ;loads D' with
                                   30H = OD ASCII
0CC5  5B           LD E, D         ,loads E' with
                                   30H = OD ASCII
0CC6  42           LD B, D         ;loads B' with
                                   30H = OD ASCII
0CC7  4A           LD C, D         ,loads C' with
                                   30H = OD ASCII
0CC8  D9           Exx             ;retrieves BCDE
                                   stores B'C'D'E'
0CC9  67           LD H, A         ,save rand. char
                                   store in H.
Save DE,BC, call interuptable delay, has key been pressed?
0CCA  D5           PUSH DE         ;save DE
0CCB  C5           PUSH BC         ;save BC
0CCC  11 02 00     LD DE, 0002     ;course delay time
0CCF  06 C0        LD B, C0        ;fine delay time
0CD1  10 FE        DJNZ            ,fine delay
0CD3  CD B9 04     CALL I.DEL      ;interuptable delay-
                                   coarse
0CD6  C1           POP BC          ;retrieve BC
0CD7  D1           POP DE          ;retrieve DE
0CD8  DA 11 0D     JMP C           ;jmp. if key has been
                                   pressed

CLOCK a) Inc C, test for 10, print C
0CDB  0C           INC C           ;inc. C(1/100th sec
                                   digit)
0CDC  DD 71 04     LD(IX+4), C     ;print new value
0CDF  3E 3A        LD A, 3A        ;3AH = 10D ASCII
0CE1  B9           COMPA,C         ,comp C with 10D
0CE2  20 E6        JRNZ            ;jmp to OCCA if no
                                   compare

      b) C = 10D, reset C = 0 print, inc B, test for 10D
0CE4  0E 30        KD C, 30        ,C = 0D
0CE6  DD 71 04     LD (IX+4), C    ;print C = '0'
0CE9  04           INC B           ;incr. B (1/10th sec
                                   digit)
0CEA  DD 70 03     LD(IX+3),B      ;print new value for B
0CED  3E 3A        LD A, 3A        ;3AH = 10D ASCII
0CEF  B8           COMPA, B        ;comp. B. with 10D
0CF0  20 D8        JRNZ            ;jmp. to OCCA if no
                                   comp

      c) B = 10,set B = 0,print B, inc E,printE,test E = 10
0CF2  06 30        LD B, 30        ;B = 0D
0CF4  DD 70 03     LD(IX+3),B      ;print B = '0'
0CF7  1C           INC E           ;incr. E (1 sec digit)
0CF8  DD 73 01     KD(IX+1),E      ;print new value for E
0CFB  3E 3A        LD A, 3A        ;3AH = 10D ASCII
0CFD  BB           COMPA,E         ;comp. E. with 10D
0CFE  20 CA        JRNZ            ,jmp  to OCCA if no
                                   comp

      d) E = 10,set E = 0,printE,incr D,test for 9,print go to
      restart
0D00  1E 30        LD E, 30        ,set E = 0D
0D02  DD 73 01     LD(IX+1),E      ;print E = '0'
0D05  14           INC D           ,incr  D (10 sec digit)
0D06  DD 72 00     LD(IX+0),D      ,print new value for D
0D09  3E 39        LD A, 39        ,39 = 09D ASCII
0D0B  BA           COMPA,D         ,comp D with 09
0D0C  20 BC        JRNZ            ,Jmp  to OCCA if no
                                   comp
0D0E  C3 92 0D     JMP             ,Jmp  to 0D92
                                   (restart)

Comp  char  pressed with char  generated continue clock if no
compare
0D11  BC           COMP A,H        ,comp key pressed
                                   (A) with random
                                   char  (H)
0D12  20 C7        JRNZ            ,jmp to OCDB if no
                                   comp

Correct key pressed, check time against best time  except if
if neg  a  is D less than D', or is D = D'
0D14  DD 7E 00     LD A, (IX+0)    ;load A with D
0D17  FD 46 00     LD B, (IY+0)    ;load B with D'
0D1A  B8           COMPA, B        ;comp D with D'
0D1B  DA C4 0D     JMPC,           ;jmp  to exx DforD'
                                   ODC4
0D1E  C2 92 0D     JMPNZ           ,jmp  to restart D
                                   greater D'

b  D = D, test if E less than E' or E = E'
0D21  DD 7E 01     LD A, (IX+1)    ,Load A with E
0D24  FD 46 01     LD B, (IY+1)    ,Load B with E'
0D27  B8           COMPA,B         ,comp  E with E'
0D28  DA CA 0D     JMPC            jmp to exx  E for E'
                                   ODCA
0D2B  C2 92 0D     JMPNZ           jmp to restart E
                                   greater E'

c  E = E, test if B less than B' or B = B'
0D2E  DD 7E 03     LD A, (IX+3)    ,Load A with B
0D31  FD 46 03     LD B, (IY+3)    ,Load B with B'
0D34  B8           COMPA,B         ,comp  B with B'
0D35  DA D0 0D     JMPC            ,jmp to exx B for B'
                                   ODDO
0D38  C2 92 0D     JMPNZ           ,jmp to restart 0D92

d  B = B',test if C is less than C'
0D3B  DD 7E 04     LD A, (IX+4)    ,Load A with C
0D3E  FD 46 04     LD B, (IY+4)    ,Load B with C'
0D41  B8           COMPA,B         ,comp  C with C'
0D42  DA D6 0D     JMPC            ,jmp to exx  C for C'
0D45  C3 92 0D     JMP             ,jmp to restart 0D92

PRINT SUB
0D48  7E           LD A,(HL)       ,put char  into Acc
0D49  DD 77 00     LD(IX+0), A     ;print char  at
                                   scrn start
0D4C  23           INC HL          next char  address
0D4D  DD 23        INC IX          ,next scrn address
0D4F  10 F6        DJNZ            ,loop to 0D48 until
                                   comp!
0D51  C9           RET             ,return to main
                                   program

CHEAT SUB
0D52  F1           POP AF          ;retrieve value A
0D53  DD 21 8C 09  LD IX, 098C     ;screen address start
0D57  21 66 0D     LD HL, 0D66     ,text start address
0D5A  06 2C        LD B, 2C        ;number of chars. (44D)
```

```
0D5C  CD 48 0D      CALL PRINT  ;prints cheat text
0D5F  DD 36 63 31   LD(IX+d),31 ;prints'1' at D (10 sec
                                digit)
0D63  C3 92 0D      JMP         ;jmp to start sub

0D66  You anticipated and cheated your penalty is:
                                ;text

RESTART SUB     a. print 'R' for Restart'
0D92  DD 21 9B 0B   LD IX, 0B9B ;scrn address start
0D96  21 DD 0F      LD HL, 0FDD ;test start address
0D99  06 0D         LD B, 0D    ;no. of chars. (13D)
0D9B  CD 48 0D      CALL PRINT  ;print restart text.

                b. check if keyboard has been pressed
0D9E  11 00 04      LD DE, 0400 ;delay time approx.
                                10secs.
0DA1  CD B9 04      CALL I. DEL ;interuptable delay
0DA4  DA AA 0D      JMPC        ;jmp. to ODAA.(key
                                pressed)
0DA7  C3 9E 0D      JMPNC       ;jmp to 0D9E (no key
                                pressed)
            c. keyboard pressed, clear restart text, reset clock
0DAA  06 2C         LD B, 2C    ;No. of chars.(cheat
                                text)
0DAC  21 8C 09      LD HL, 098C ;scrn start address
0DAF  16 20         LD D, 20    ;ASCII space char.
0DB1  72            LD(HL),D    ;clears 1st pos. of
                                cheat text
0DB2  23            INC HL      ;next screen position
0DB3  10 FC         DJNZ        ;jmp to 0DB1 loop
                                until compl.
0DB5  06 0D         LD B, 0D    ;no. of chars (reset
                                text)
0DB7  21 9B 0B      LD HL,0B9B  ;screen start address
0DBA  72            LD(HL),D    ;clears 1st position
0DBB  23            INC HL      ;next screen position
0DBC  10 FC         DJNZ        ;jmp to 0DBA until
                                complete
0DBE  FD 72 24      LD IX, D    ;clears char. space
0DC1  C3 B6 0E      JMP         ;jmp to 0EB6 (reset
                                time)

EXCHANGE SUB AND'PRINT NAME' SUB a. EXX sub.
0DC4  DD 7E 00      LD A, (IX+0) ;Load A with D
0DC7  FD 77 00      LD(IY+0),A  ;print D into D'
0DCA  DD 7E 01      LD A, (IX+1) ;Load A with E
0DCD  FD 77 01      LD(IY+1),A  ;print E into E'
0DD0  DD 7E 03      LD A, (IX+3) ;load A with B
0DD3  FD 77 03      LD(IY+3),A  ;print B into B'
0DD6  DD 7E 04      LD A, (IX+4) ;load A with C
0DD9  FD 77 04      LD(IY+4),A  ;print C into C'

                                b. Print Name sub.
0DDC  CD 28 00        CALL PRINT STRING
0DDF  /PRINT/NAME//////         ;text (/ = space 20H)
0DF0  00              END OF STRING
0DF1  21 8A 0B      LD HL, 0B8A ;cursor scrn pos.
0DF4  36 5F         LD(HL),5F   ;5F = cursor ASCII
0DF6  22 18 0C      LD(CUR),HL  ;new cursor address,
                                resets cur.
0DF9  06 10         LD B, 10    ;no. of chars.(16D)
0DFB  CD 3E 00      CHIN        ;char input from
                                keyboard
0DFE  CD 3B 01      CRT         ;prints character
0E01  10 F8         DJNZ        ;loop until complete
0E03  21 8A 0B      LD HL, 0B8A ;cursor scrn pos.
0E06  36 5F         LD(HL),5F   ;5F = CUR ASCII
0E08  22 18 0C      LD(CUR),HL  ;resets cursor.
0E0B  C3 92 0D      JMP         ;jmp to restart 0D92

SEARCH TABLE

0E20  01 90 0E      0E90 30     ;0
0E23  02 91 0E      0E91 31     ;1
0E26  03 92 0E      0E92 32     ;2
0E29  04 93 0E      0E93 33     ;3
0E2C  05 94 0E      0E94 34     ;4
0E2F  06 95 0E      0E95 35     ;5
0E32  07 96 0E      0E96 36     ;6
0E35  08 97 0E      0E97 37     ;7
0E38  09 98 0E      0E98 38     ;8
0E3B  0A 99 0E      0E99 39     ;9
0E3E  0B 9A 0E      0E9A 41     ;A
0E41  0C 9B 0E      0E9B 42     ;B
0E44  0D 9C 0E      0E9C 43     ;C
0E47  0E 9D 0E      0E9D 44     ;D
0E4A  0F 9E 0E      0E9E 45     ;E
0E4D  10 9F 0E      0E9F 46     ;F
0E50  11 A0 0E      0EA0 47     ;G
0E53  12 A1 0E      0EA1 48     ;H
0E56  13 A2 0E      0EA2 49     ;I
0E59  14 A3 0E      0EA3 4A     ;J
0E5C  15 A4 0E      0EA4 4B     ;K
0E5F  16 A5 0E      0EA5 4C     ;L
0E62  17 A6 0E      0EA6 4D     ;M
0E65  18 A7 0E      0EA7 4E     ;N
0E68  19 A8 0E      0EA8 4F     ;O
0E6B  1A A9 0E      0EA9 50     ;P
0E6E  1B AA 0E      0EAA 51     ;Q
0E71  1C AB 0E      0EAB 52     ;R
0E74  1D AC 0E      0EAC 53     ;S
0E77  1E AD 0E      0EAD 54     ;T
0E7A  1F AE 0E      0EAE 55     ;U
0E7D  20 AF 0E      0EAF 56     ;V
0E80  21 B0 0E      0EB0 57     ;W
0E83  22 B1 0E      0EB1 58     ;X
0E86  23 B2 0E      0EB2 59     ;Y
0E89  24 B3 0E      0EB3 5A     ;Z
0E8C  00                        ;end of table
0E8D  00            NOP
0E8E  00            NOP
0E8F  00            NOP
0EB4  00            NOP
0EB5  xx                        ;workspace for R,N,G,

RESET TIME TO 00:00

0EB6  DD 21 1B 0A   LD IX, 0A1B ;scrn pos.
0EBA  21 A7 0F      LD HL, 0FA7 ;text address start
0EBD  06 0E         LD B, 0E    ;no. of chars. (15D)
0EBF  CD 48 0D      CALL PRINT  ;print
0EC2  C3 97 0C      JMP         ;jmp to start 0C97

TEXT (/ means space character 20H)

0F00 REACT/O'/TIME
0F0D When/a/character/appears/on/the/screen
0F33 press/the/SAME/character/on. the. keyboard
0F5C YOUR/REACTION/TIME/IS...
0F75 99:99
0F7A BEST/TIME//////////////////////CHARACTER
0FA7 00:00//seconds
0FDD R/FOR/RESTART
```

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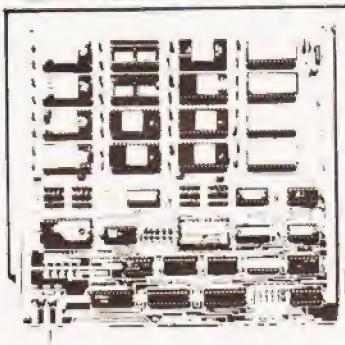

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MICRO'S IN AMATEUR RADIO

Paul Jessop

With the ever increasing popularity of ham radio, the MPU again appears to be helping out.

Being a largely technical hobby, many amateur radio enthusiasts are interested in home computing and, to a rather more limited extent, vice versa. Naturally, the question arises how to use the home computer as an aid to amateur radio. There are of course a myriad of ways in which this can be done and I hope that this article will explain some of the facets of modern amateur radio operation and, more importantly, fire a few imaginations.

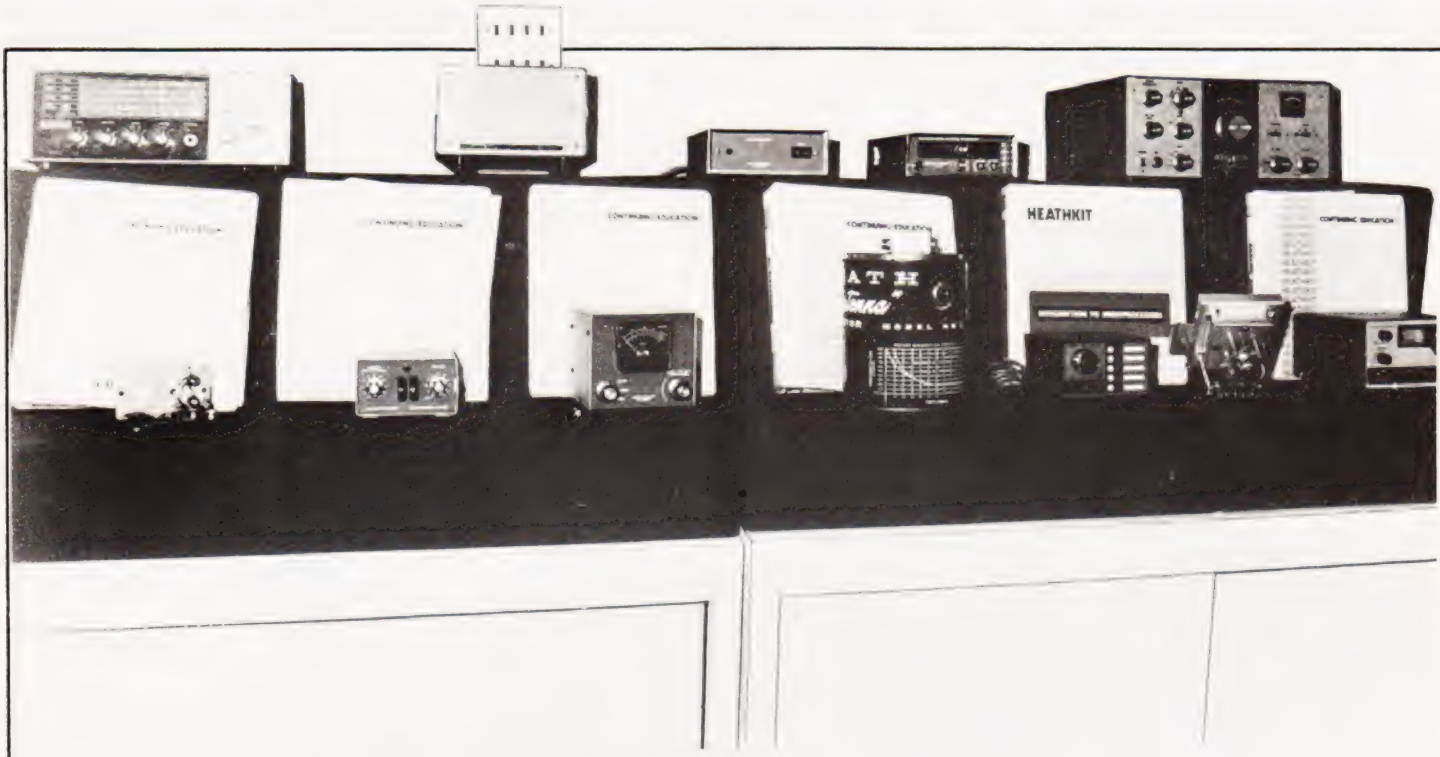
Similar Structures

The first field in which the computer can most easily be applied is that of morse operation. Morse is by its very nature a binary (on-off) signal and can therefore be readily interfaced to a digital system. The computer can read the morse signal from an input port and decode it into alphanumeric characters which it displays or prints. Similarly, the reverse process can be performed with characters from the keyboard being stored in a buffer and transmitted as perfectly formed morse characters at any desired speed. The receiving function can quite easily adapt to changes in sending speed but it will take several characters for the program to 'lock-on' from cold. For a particular mode of operation it is very important that a few fragmented characters are interpreted correctly. This is meteor scatter operation; the radio waves are bounced not off the meteors themselves, which may be as small as a grain of sand, but off the trail of ionization which they leave behind them. The ephemeral nature of these trails means that the reception is of very short 'pings' of signal. If a prearranged speed is used for transmission, and the decoding system is 'tuned' to this speed, all the characters in the 'ping' may be used except the first and the last which may be truncated. This will of course be most convenient if the transmission if from a computer system from, not the keyboard, but a message stored in memory and continuously repeated. The receiving computer can then assimilate all the received characters into their possible locations in the message.

Radio Your TTY

A field somewhat similar to morse is that of radio-teletype (RTTY). In this case, rather than sending a letter as a series of dots and dashes, it is represented as a five-bit binary group which is sent in asynchronous form, that is the system idles in the '1' state (mark) and when a character is to be sent, a '0' pulse of 22 mS is sent and this is immediately followed by the five binary bits representing the character. These pulses are of 22 mS each and the character is ended by a stop pulse of 33 mS of mark, in which state the system idles until the start of the next character. A similarity will be noticed between this and the eight-bit ASCII code used for computer interfacing. However, the eight-bit code (which is really seven-bits plus parity) contains sufficient combinations to represent all wanted characters; the five-bit code does not. For this reason, two codes are defined as 'letters shift' and 'numbers shift'. These shift the character set into the wanted group. The existence of this shift system makes conversion between the five and eight-bit codes quite easy in the RTTY to ASCII direction but extremely difficult in the reverse direction, in hardware at least. The problem is that the translated code may contain any number of shift characters so there is no one-to-one correspondence between the input and the output of the converter. However, if the problem is tackled in software there is not nearly so large a problem since a buffer can be used to take up any difference between the input and output data rates.

Given a system similar to that described above for morse communication, many things can be done to extend it in RTTY usage. These are rather different in nature from the morse applications because of the very different characteristics and uses of the mode. If the receiver is left to monitor a channel all day, all the traffic on that channel could be printed. Using a computer it could be dumped to floppy disc whence it could be reviewed at the end of the day and any pertinent parts printed. This is really a rather trivial function for the computer



A selection of amateur radio equipment from Heathkit. Our thanks are due to them for letting us use their London shop for photography.

and uses its power to a very limited extent. By designing intelligence into the system, it can be made much easier to use. The computer could look at the traffic on the channel and check it for the user's callsign. Only then would it make a record onto floppy disc or cassette tape.

It would be a relatively simple matter to write a program which would call continually and, when replied to, extract the calling station's callsign and conduct a reasonably normal contact. This is of course hardly Amateur Radio in the true sense and spirit of the term but it does show what could be done, given a need. This kind of system might be useful for contests but the amateur radio licence does insist on attended operation, ie. operation in the physical presence of the licensee.

Slowly Scanned

More in the spirit of amateur radio would be a system where the normal procedure of typing from a keyboard was used with the added facility that certain fixed messages were available from the keyboard. These might include a description of the station, a "QUICK BROWN FOX . . ." test message or one of the many computer graphics pictures which are in circulation.

A mode where digital techniques are already widely used is slow scan television (SSTV). This differs from normal television in that it is a low definition system with only 128 lines per frame and a frame taking eight seconds to transmit. In the early days, and to a considerable extent today, reception was by viewing an image generated on a long persistence cathode ray tube, but recently it has become possible to store the picture and display it, frozen, on a normal TV screen. The initial models used dynamic shift registers to store the picture but it is now more convenient to use RAM and what better way to control it than a microprocessor? Using 128 lines with 128 picture elements (pixels) per line, there are 16K pixels per frame and, if each one can take any one of 16 grey scale intensities requiring four-bits per pixel, a total of 64K bits per frame is needed. This may seem a lot but in fact this amount of storage is contained in an 8K byte memory board. Pictures can be received, stored, dumped to a mass storage device, created and transmitted using this system. The creation of pictures can be carried out using a normal cursor or with a light-pen. Alternately, dot-matrix characters can be formed from keyboard input.

Up to now, I have dealt mainly with the ways in which the individual amateur can use a home computer as part of his station but there are many "utilities" in amateur radio which are constructed, paid for, and used by amateurs. These are repeaters and beacons. Beacons are transmitters which are located on high masts and hills and radiate on a well defined frequency sending, usually, just their callsign in morse at frequent intervals. They are used as a guide to propagation, the more distant beacons becoming audible during periods of good conditions. Repeaters are relay stations, again sited on high points, which receive on one frequency and re-transmit on another. To avoid misuse, the user has to start his transmission with a brief tone of 1750Hz to "access" the repeater and then has usually about a minute of talkthrough until the machine 'times out' and cuts him off.

At present, both beacons and repeaters are controlled by, normally, TTL logic which is very power consuming and difficult to modify. To control a beacon with a microprocessor would enable not only morse but also RTTY, SSTV, etc., to be sent. It would also be possible to have the beacon relay the weather conditions at the transmitter site. This would be of considerable value in propagation forecasting. In addition, the beacon could contain a short message programmed over a telephone line which could be broadcast periodically; this could be useful for emergency warnings and notice of abnormal propagation conditions. In the recent years, speech synthesis equipment for computers has become quite cheap so a beacon with speech announcement could be produced, although this would be of dubious value in view of the much better communication efficiency of morse under weak signal conditions.

Repeating Yourself

The comments above about beacons also apply to repeaters. Here, the use of speech synthesis is much more appropriate because of the strong-signal nature of repeater operation. At present the only facility, other than talkthrough, available from a repeater is a frequency measurement which tells the user if his transmission is high or low in frequency. By extending the tone-access procedure, it is not difficult to see how a whole new series of facilities could be added. By prefixing his transmission with a multiple tone-burst, the user could: make the repeater digitise a few seconds of speech and replay it to show the speech quality, have his signal strength or audio level measured, or select a different antenna system. The list is endless. Britain now has a specialised RTTY repeater sited at Barkway. The possibilities for the microprocessor control of machines such as these are fascinating. Direct alphanumeric input makes control much easier for the accessing station and by insisting on a particular format, the repeater could compile a list of all the accessing stations. Some of the facilites which could be included would be the storage of messages for a station not at that time on the air, the measurement of the important timing parameters of the user's signal and even the direct execution of programs sent to the repeater over the radio link.

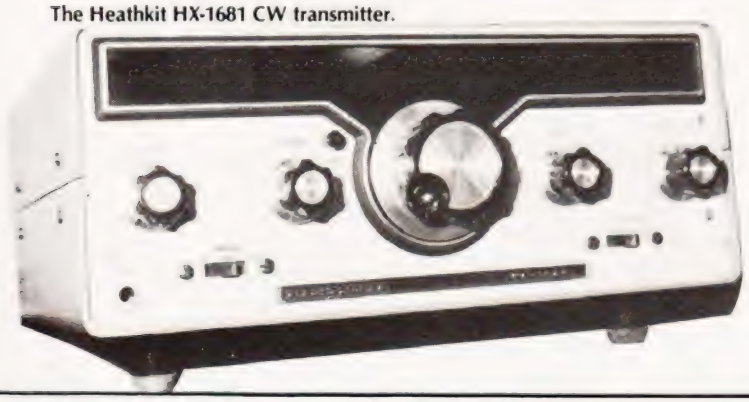
At present out of the question, for reasons of licensing, (but worthy of consideration for the future) is the linking of repeaters to form a nationwide network. A message could be put onto the system at any of the repeater stations and from there it would be routed by the most efficient course to its destination.

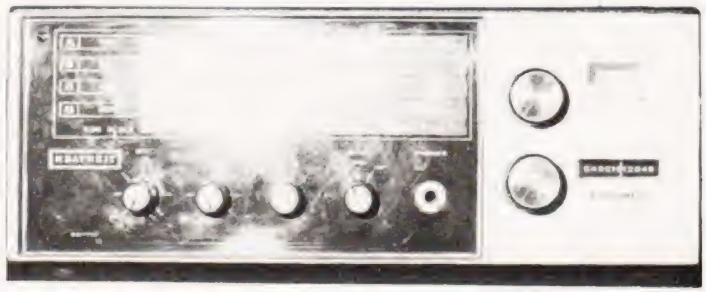
A very specialised type of repeater is the amateur satellite. Known as OSCARs (Orbital Satellite Carrying Amateur Radio) they are built by amateurs and launched by NASA with their own satellites. They carry repeaters and beacons as well as a very sophisticated control system which is already microprocessor controlled.

Use of the OSCAR satallites requires very directional aerials which have to be steered accurately as the satellite passes over. One has to know in advance just when the satellite will appear. In both of these tasks, the home computer can perform the necessary calculations. Orbital data is very accurately known for the satellites and from this, the times of the passes can be worked out. This will alert the operator as to when to expect the pass, and during it the computer can control the direction of the antenna.

Computer contol of antenna direction can be useful in other areas as well. For instance in EME (Earth-Moon-Earth) operation, signals are bounced off the moon and antennas must be very accurately aimed for effective communication. With this being done automatically, the operator can concentrate on the serious business of listening for very weak signals amongst the noise.

The Heathkit HX-1681 CW transmitter.





A Heathkit short wave receiver, if you just want to listen.

More mundanely, the home computer can be used as a data retrieval service. Entering a station's callsign will then cause the operator's name and optimum antenna heading to be recalled from memory or backing store and displayed. As above, the antenna could be automatically rotated to the correct direction. An extension of this would be for the computer to do all the logging at the station. The files thus created could be interrogated at a later date and searched for all contacts made on a particular day, with a particular station or by any of the other stored parameters.

Micros Inside

Only recently launched onto the market are a series of transmitter-receivers which have digitally synthesised frequency control. Happily, the manufacturers have seen fit to provide a socket on the back of the unit for interface to the synthesiser by a computer. The range of possibilites which this opens up is enormous. The unit can, for example, be made to scan the whole of a band and display the clear or occupied frequencies. Alternatively, it could be made to scan a particular set of frequencies until one becomes occupied when it will lock onto that frequency until instructed to do otherwise by the user. It would then resume scanning but *excluding* that frequency. Thus the operator will not be troubled by the system repetitively locking onto a repeater output or a strong local station. The next step would be for a timing element to be introduced. Then the scanner would only exclude a rejected frequency for, say, five minutes so that the user would miss as little as possible of activity.

It would also be possible for a specified frequency to be checked periodically during operation on another frequency. The receiver would be briefly switched to this frequency at intervals and the user alerted if any signal appeared there. The amount of information content lost from the primary frequency would be very low and the facility would be of considerable use when waiting for an arranged contact.

Finally, it must be related that work is being done at present on self-correcting communication systems by amateurs. Briefly, these have an intelligent terminal at either end and, when a character is lost due to fading, interference etc., the receiving station goes to transmit and requests a repeat of the missing characters. This results in a dramatic increase in the proportion of correctly received characters under poor conditions. Although widely used by professional and commercial radio users, it has not been used by amateurs before and refinements can be expected.

Home computer users who are inspired to enter amateur radio are warned that it is necessary to pass a technical examination before the Home Office will issue a licence but this should not pose any problems to someone seriously interested. Further information about Amateur Radio can be obtained from: The Radio Society of Great Britain. 35 Doughty Street, London WC1N 2AE.

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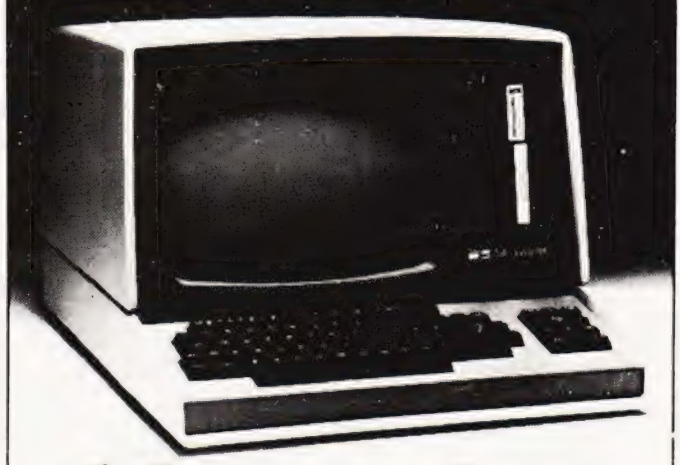
Z89.



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Z89

A. Gavriluk

Destruction Derbies in your own living room with no damage to the paintwork.

This is a dynamic game intended to run directly on the NASCOM 2. The rules of the game are as follows:- Your sole intention is to get as high a score as possible by running your car into the others as many times as possible. You manipulate your car around the screen with the cursor control keys. To stop the car press any other character key.

Every time you hit a car a cross will appear. Hitting this will cause a deduction of five points from your final score. The same applies if you hit the boundary. In both cases you are put back in the centre. You are allowed eight time units at the start in which the cars are stationary. This is to give you a chance to hit as many cars as possible before they start to move at time -1.

The game terminates at time 50. Your final score is given and if you have broken the record your score is made the new record

Program Notes

The initial number of cars is a random number between six and 16. The number or cars remains constant throughout the game, ie they are not destroyed when you hit them.

If you want to make it run on another machine then you will have to change all the POKE statements and also install a suitable keyboard scan function or machine code program for the car steering.

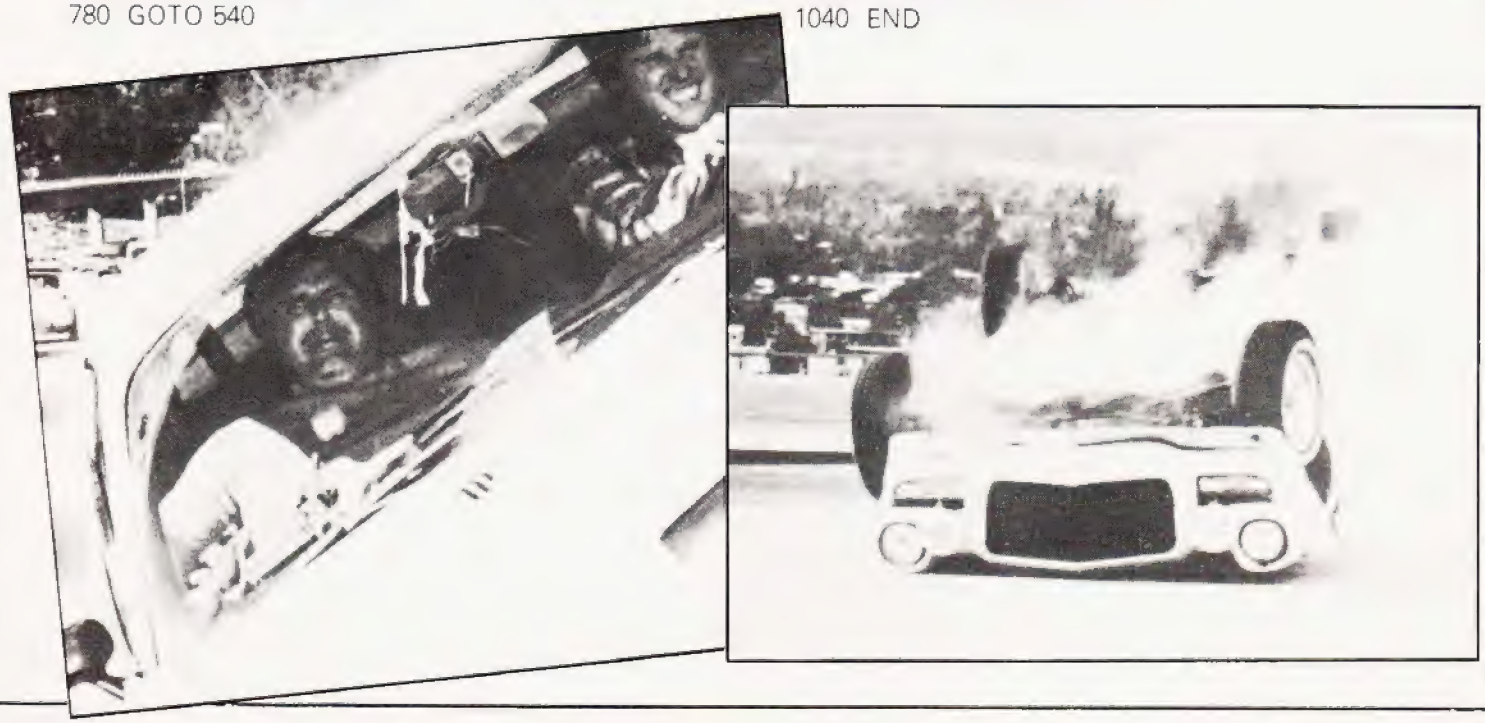
It will be seen that most of the program deals with the time, accident and score writing to the sixteenth line (lines 390-530, 790-820 & 840-870). I expect this lot could be shrunk into one universal subroutine if space is at a premium. It should be noted that the numbers are POKEd to different screen locations.

If you want to go round the screen at 90 MPH; try reducing the delay loop at line 650. If you want a longer game (say 99) then change line 480.

Program Listing

```
 0 CLS
 2 A$="STOCK CAR"
 4 FOR A=1 TO LEN(A$)
 6 SCREEN A+14,16
 8 PRINT MID$(A$,A,1)
10 NEXT
15 PRINT:PRINT"YOU STEER A MAN AROUND
   THE SCREEN WITH"
20 PRINT"THE CURSOR CONTROL KEYS. EVERY
   TIME YOU"
25 PRINT"HIT A CAR YOUR SCORE WILL
   INCREMENT. IF"
30 PRINT"YOU GO OFF THE SIDE YOUR
   ACCIDENT COUNT"
35 PRINT"WILL INCREMENT. EVERY ACCIDENT
   YOU HAVE"
40 PRINT"YOUR SCORE WILL GO DOWN BY 5.
   WHERE YOU"
45 PRINT"HAVE HIT A CAR A CROSS WILL
   APPEAR. IF YOU"
50 PRINT"HIT THIS THEN THE ACCIDENT
   ROUTINE FOLLOWS"
55 PRINT"TO STOP THE CAR PRESS ANY
   CHARACTER KEYS"
60 PRINT"YOU ARE ALLOWED 8 TIME DIGITS
   AT THE START"
65 PRINT"IN WHICH THE CARS ARE
   STATIONARY. THE GAME"
70 PRINT"ENDS AT 50 (TIME). THE SCORE IS
   GIVEN ALONG"
80 PRINT"WITH THE RECORD."
90 FOR A=1 TO 29999:NEXT
100 A1=0:DIM H(20)
110 CLS
120 A$="TIME     ACCIDENTS     SCORE"
125 REM**WRITE TITLE TO LINE 16
130 FOR D=1 TO LEN(A$)
140 SCREEN D+5,16
150 PRINT MID$(A$,D,1)
160 NEXT
170 B=2954:C=2122
180 FOR A=2058 TO 2105
185 REM**SET UP BOUNDARIES
190 POKE A,5:POKE B,5
200 IF C>3001 THEN 230
210 POKE C,5:C=C+47
220 POKE C,5:C=C+17
230 B=B+1
240 NEXT
250 E=INT(10*RND(1)+6)
260 FOR F=1 TO E
270 G=INT(900*RND(1)+2090)
275 REM**SET UP RANDOM CAR POSITION
280 IF PEEK(G)<>32 THEN 270
290 POKE G,14
300 H(F)=G:REM**STORE POSITIONS IN LIST H
310 NEXT
315 REM**SET UP MACHINE CODE KEYBOARD
   SCAN
320 DOKE 3200,25311:DOKE 3202,312
330 DOKE 3204,18351:DOKE 3206,10927
336 REM**THIS IS STRUCTURED THE SAME AS
   ACCIDENT
340 DOKE 3208,-8179:POKE 3210,233
350 DOKE 4100,3200
360 I=2595
370 POKE I,7:REM**PUT CAR IN CENTRE OF
   SCREEN
380 K=45:J=57:L=0:X=0:W=0:Y=0:S=49:
   U=S:T=48:V=T
385 REM**LINES 390-540 TIME WRITING TO LINE
   16
386 REM**380 IS INITIALISATION OF MOST
   FUNCTIONS
390 IF K>46 THEN 440
400 POKE 3029,K:POKE 3030,J
410 IF J=49 THEN K=48
420 J=J-1
430 GOTO 540
440 IF J>48 OR K>48 THEN 480
450 POKE 3029,K:POKE 3030,J
```

```
460 J=J+1
470 GOTO 540
480 X=X+1:IF X=50 THEN 880
490 J=J+1:IF J=58 THEN 520
500 POKE 3030,J
510 GOTO 540
520 K=K+1:POKE 3029,K
530 J=48:POKE 3030,J
540 L=L+1:IF L=F THEN L=0:GOTO 390
550 IF K=45 THEN 650
560 M=INT(4*RND(1)+1)
565 REM**START RANDOM MOVEMENTS OF
    MEN
570 IF M=1 THEN N=64
580 IF M=2 THEN N=-1
590 IF M=3 THEN N=1
600 IF M=4 THEN N=-64
610 IF PEEK(H(L)+N)=5 THEN 560
620 POKE H(L),32
630 H(L)=H(L)+N
640 POKE H(L),14:REM**POKE IT ONTO SCREEN
650 FOR O=1 TO 10
660 P=USR(0):REM**CALL UP M/C KEYBOARD
    SCAN
670 IF P=0 THEN 690
680 Q=P
690 NEXT
700 R=I
710 IF Q=17 THEN I=I-1
720 IF Q=18 THEN I=I+1
730 IF Q=19 THEN I=I-64
740 IF Q=20 THEN I=I+64
745 REM**DETECT WHETHER A BOUNDARY OR
    CAR HIT
746 REM**ALTER POSITION OF CAR
750 IF PEEK(I)=5 OR PEEK(I)=25 THEN 790
760 IF PEEK(I)=14 THEN 840
770 POKE R,32:POKE I,7
780 GOTO 540
785 REM**START OF ACCIDENT WRITING TO
    TOP
790 W=W+1:POKE R,32:IF S>57 THEN T=T+1:
    S=48
800 POKE 3045,T:POKE 3046,S
810 S=S+1
820 I=2595:POKE I,7:Q=0
825 REM**RE-POKE THE CAR TO INITIAL
    POSITION
826 REM**AND KILL THE AUTO-HOLD FEATURE
830 GOTO 540
835 REM**START OF SCORE WRITING TO TOP
840 Y=Y+1:POKE R,25:IF U>57 THEN V=V+1:
    U=48
850 POKE 3059,V:POKE 3060,U
860 U=U+1
870 GOTO 540
880 CLS
890 PRINT TAB(10);"GAME OVER          END"
900 PRINT
910 PRINT TAB(4);"SCORE";TAB(37);Y
920 PRINT TAB(4);"ACCIDENTS = (TIMES FIVE)";
    TAB(36);" - ";W
930 PRINT TAB(35);"-------"
940 PRINT TAB(4);"TOTAL" =";TAB(37);:Z=W*5:
    PRINT Y-Z
950 PRINT TAB(35);"- - - - - -"
960 IF Y-Z>A1 THEN 990
970 PRINT:PRINT TAB(10);"RECORD SCORE=";
    A1
980 GOTO 1010
990 A1=Y-Z
1000 PRINT TAB(10);"YOU'VE JUST SET A NEW
    RECORD"
1010 PRINT:PRINT:PRINT:INPUT"DO YOU WANT
    ANOTHER TRY";C$
1020 IF LEFT$(C$,1)="Y"THEN Q=0:GOTO 110
1030 PRINT"PROGRAM END"
1040 END
```



Why the Sinclair ZX80 is Britain's best-selling

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Powerful ROM and BASIC interpreter

The 4K BASIC ROM offers remarkable programming advantages:

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* Unique syntax check. A cursor identifies errors immediately.
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* Variable names of any length.
* BASIC language also handles full Boolean arithmetic, condition expressions, etc.
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The ZX80's 1K-BYTE RAM is the equivalent of up to 4K BYTES in a conventional computer – typically storing 100 lines of BASIC.

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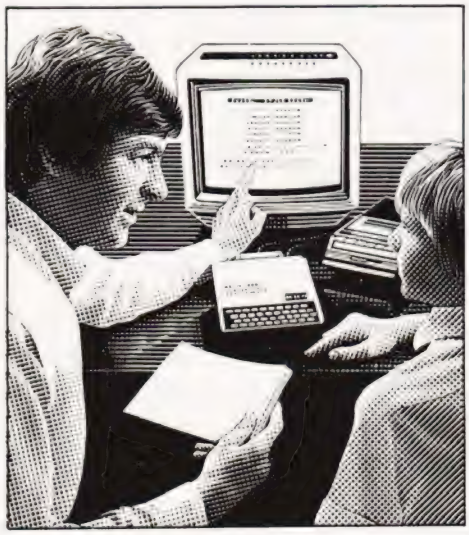

The ZX80 as a family learning aid. Children of 10 years and upwards are quick to understand the principles of computing – and enjoy their personal computer.

The Sinclair teach-yourself BASIC manual

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book (free with every ZX80). The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs.

Kit or built – it's up to you

In kit form, the ZX80 is pleasantly easy to assemble, using a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9V DC nominal unregulated. If not, see the coupon.

Both kit and built versions come complete with all necessary leads to connect to your TV (colour or black and white) and cassette recorder. Plug in and you're ready to go. (Built versions come with mains adaptor.)

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Applications

The Video Genie System has many uses in all spheres of life, the easy to use BASIC language means that programs are easily written for specific applications, and pre-recorded program tapes are available in great variety.

The system has great scope in the home, sophisticated games programs can introduce the computer age to all the family, who can then progress to writing their own programs in BASIC or even machine code. Software is continuously being developed to aid home budgeting and education.

In a school or college the machine can be used with a large screen TV to allow a whole class to be taught at once.

The powerful Extended BASIC interpreter makes the solution of complex scientific problems simple, and the graphics allow pictorial displays of results.

Cassette Unit

The Video Genie has an integral cassette system which can save information on standard tape cassettes. An interface is also provided to connect an external audio cassette unit for greater storage flexibility.

Expansion

The EG3013 EXPANDER (expansion unit)

is designed to upgrade your VIDEO GENIE SYSTEM, from a personal computer to a powerful microcomputer system, in the most flexible and inexpensive way. All resident interfaces are fully buffered to ensure reliability.

The Parallel Printer Interface will operate any printer, which has Centronics standard parallel interface, to provide hard copy printout.

2. Mass Storage and Fast Access

The Disk Controller Interface can handle up to 4 sets of mini-floppy disk drives (compatible types as Shugart SA-400 and Pertec FD-200).

Storage options: i) Single side, single/double track density 35/40/77 tracks.
ii) Double side drives can also be used provided their side select signals are modified. If using double side, the Disk Interface can only handle 2 drives instead of 4.

Disk Operating System options: TRSDOS; NEWDOS; MICRODOS; VTOS.

3. Communications

The RS-232-C Interface (optional) can be connected to telephone modem or other form of carrier to provide data communication capabilities. Besides communications, it can also be used to operate RS-232-C standard serial printers.

4. Memory Expansion

Memory capacity can be expanded from the basic 16K to 32K/48K by insertion of RAM CARD (not inclusive in the EG3013 EXPANDER package), into either one of the two remaining S-100 slots.

5. S-100 Bus Expansion

Optional S-100 Bus standard cards (such as controller cards) can be plugged into either one of the two remaining S-100 slots for further system expansion.

Prices	Nett	Vat	Total
Video Genie Computer	280.00	42.00	322.00
EG3013 Expander with RS232	215.00	32.25	247.25
EG3013 Expander without RS232	185.00	27.75	212.75
32K Memory Board S100	130.00	19.50	149.50
16K Memory Board S100	95.00	14.25	109.25
Single Disk Drive	215.00	32.25	247.25
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2 Drive Cable	17.00	2.55	19.55
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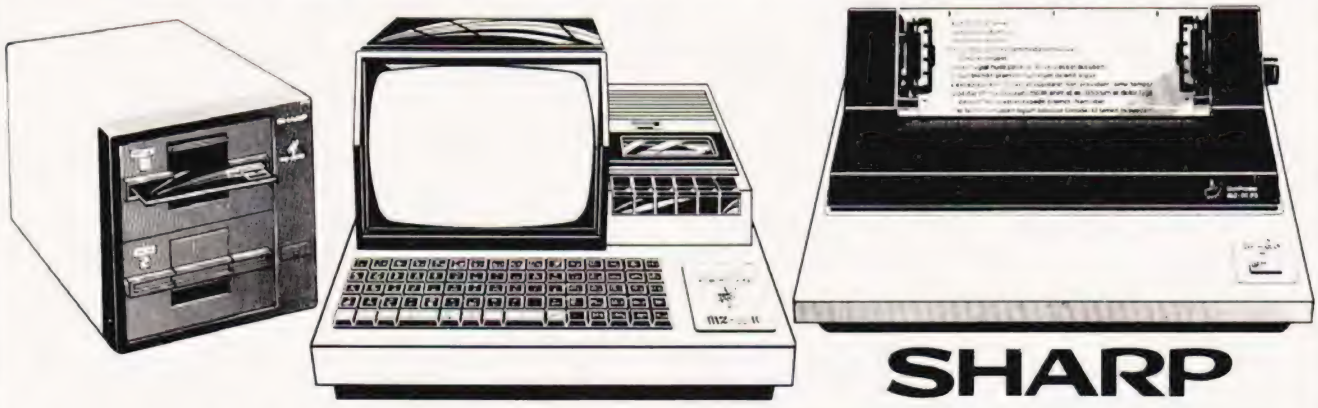

Famed for its quality and reliability the MZ 80K is very competitively priced.

Notable features of the basic unit are the built in 3 Octave Music Synthesiser and the high speed (1200 bps) of the cassette interface.

Systems expansion is via an interface unit (MZ 80 I/O) into which are connected the printer, the dual disk drive, the second dual disk drive and the universal interface card.

The basic unit comes with a 14K BASIC interpreter and the disk drives come with an enhanced disk version of this. Alternatively xtal BASIC can be used with the computer and the industry standard CP/M disk operating system is available for disk based systems.

Ledgers and stock control software are available free when full systems are purchased.

Prices	Nett	Vat	Total
MZ 80K Computer 48K RAM	460.00	69.00	529.00
MZ 80 I/O Interface Unit	82.00	12.30	94.30
MZ 80 FD Dual Disk Drive	640.00	96.00	736.00
MZ 80 FDK Dual Add-on Drives	565.00	84.75	649.75
MZ 80 P3 Printer	415.00	62.25	477.25
MZ 80 I/O-1 Universal Interface Card	40.00	6.00	46.00
MZ 80 TU Assembler	36.00	5.40	41.40
MZ 80 T20C Machine Language	18.00	2.70	20.70
XTAL BASIC	40.00	6.00	46.00
CP/M Disk Operating System	200.00	30.00	230.00

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PC1211
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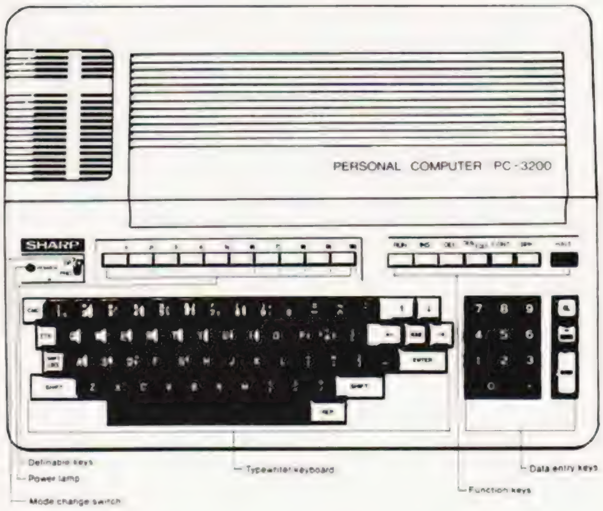
Sharp PC 3200 Desk Top Computer System

Microdigital Guarantee now extended to **2 years** on all Sharp and Apple hardware purchased after 1.1.81

Sets new high standards for big microcomputer systems.



This is the machine all the others will have to beat with a fabulous list of features

RAM
64K – (expandable to 96K summer 1981).

ROM
32K (expandable up to 72K) including BASIC Interpreter.

Video Monitor
Green displays
80 chars x 25 lines) Selectable
40 chars x 25 lines)
Reverse video
Blinking video
Selected scrolling – Left, right, up and down
Pseudo line and matrix drawing function.
Graphic function = 160 x 50 dots.

Keyboard
Full ASCII format typewriter style
Numeric key pad
Cursor control keys
10 User definable keys
7 function keys
Repeat key.
96 character keyboard buffer.

Clock and Calendar
Built in Clock and Calendar with rechargeable battery back-up.

Printer
80/132column dot matrix logic seeking bi-directional printer.
Double width print.
Upper & Lower case plus graphic charocters.
Pin Feed.

Floppy Disks
Twin 5¼" disk unit giving total capacity of 568K.
Double sided – Double density.
Up to 8 drives can be connected
giving total capacity of 4.5 megabytes.

Future Entrancements
8 inch Floppy disks – 1 Megabyte capacity (available Summer 81)
RS 232C Interface – (available Summer 81)
General Purpose I/O Card – (availble Autumn 81)

The BASIC supplied with the PC 3200 is one of the best yet available. The following is a list of some of the enhancements over other BASIC interpreters.

Statements
Dim – Multi-dimensional arrays in excess of two.
Print Using Call – Print formatted as specified in IMAGE Statement.
"Subprogram" – Call "SUBPROGRAM" with specified parameters.
DFK – Define the definable keys.
Keyin – Enables precise definition of input format for both – numeric and string variables.
Move – Creates string variables of any length greater that 255. – Also enables the copying of sections of program.
Search – Search for a variable or any array for a specified – string and the string position is returned into a specified – numeric variable.
Wait – Program execution is halted for a specified interval or – until a specified time.
BL – Sets C.R.T. to blinking in specified area.
RV – Sets C.R.T. to reverse video in specified area.
Line – Draws ruled lines either horizontal or vertical according to specified parameters.
Scrol – Specified areas of the C.R.T. can be scrolled left, right, – up or down.
Table – Forms a lattice on the C.R.T. using ruled lines or a – specified character.
Merge – Merges two BASIC programs.
Aload – Causes the ALOADED Program to be loaded and RUN – at power ON.
Debug – Machine code programming utility.

Commands
Auto – Auto line numbering.
Delete X, Y – Delete Program lines X -Y.
Edit X – Edit program line X.
Erase A (*) – Clear numeric array variable A.
List print – Print the whole program with page No. date & time, – and "TITLE" being printed on each page.
Ren – Renumber program.
TR – Trace the execution of the program.

Disk Statements
Statements allow both random and sequential data files to be handled.
Programs can be stored in either ASCII or binary format.
VSAVE/VLOAD – Stores/Loads the contents of the C.R.T. in a disk – file.
VSAVE*/VLOAD* – Stores/Loads the ruled lines, reverse video – and blinking state of C.R.T. in a disk file.

The PC 3200 is sold only as a complete system consisting of
- computer
- dual disk drive
- printer
- video monitor
- all plugs and leads

Price	Nett	Vat	Total
PC 3200 System	2995.00	449.25	3444.25

Place your order now to get one of the first machines in the U.K.

SHARP

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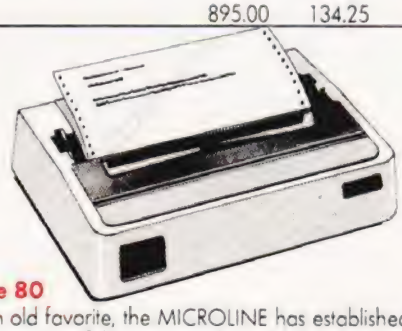
Printers

Watanabe 'Digi Plot'

Now a low cost Plotter easily interfacable to a micro computer. The DigiPlot incorporates all intelligent functions required for producing graphs and drawings. There are many uses for this Plotter ranging from design, research and development to administrational flowcharts and graphs. Control is via a 7-bit.ASCII Parallel interface. This can be interfaced to nearly any microcomputer using set subroutines.

Price	Nett	Vat	Total
'Digi Plot'	895.00	134.25	1029.25



Microline 80

Now an old favorite, the MICROLINE has established itself on the market as one of the most reliable and versitile printers availible. This quiet 5 x 7 dot matrix printer prints at 80cps and is capable of producing graphical output. It comes complete with 96 character set and centronics compatible interface. You can select from 40,80 and 132 characters per line in software. The 40 character output is double-size, 80 character is at 10 cpi, 132 character is at (16.5 cpi). Now at a new low price, exceptional value.

Price	Nett	Vat	Total
MICROLINE 80	395.00	59.25	454.25
Ribbons (available in blue, black, green, red and brown)	2.25	0.34	2.59

Paper Tiger (Models 460 and 560)

These are the latest models from the TIGER family. The 460 has higher speed (120 cps) and prints bi-directionally. There is a 96 character set which can be printed at 80,96 or 132 characters per line. The 9 x 9 dot matrix head has a life of 300 million characters and gives a very good print quality. RS232 and parallel interfaces are available. The 560 option is slightly quicker (120-160 cps) and is a full 132 column machine. It can accomodate 15 inch paper and has two print and speed modes. Naturally both these printers have full graphical capability.

Price	Nett	Vat	Total
Model 460	795.00	119.25	914.25
Model 560	995.00	149.25	1144.25
Paper (2000 sheets)	31.00	4.65	35.65

Seikosha GP-80

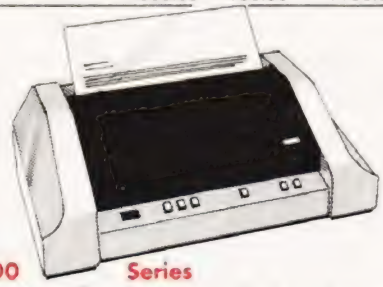
At last, an economic printer for the hobbyist. This must be the lowest-cost smallest impact graphic printer in the world. Graphics, normal (12 cpi) and double-width (6 cpi) characters can be printed on the same line. Pinfeed tractor is equipped as standard. The printer prints on plain paper and has a continuous self-inking ribbon. There is a wide range of optional interface boards availible. A truly remarkable dot matrix printer, it prints at 30 cps using a 5 x 7 dot matrix. A parallel interface is standard.

Price	Nett	Vat	Total
GP-80	250.00	37.50	287.50
Interfaces:			
RS232c	50.00	7.50	57.50
IEEE 488 or APPLE II	30.00	4.50	34.50
PET	32.00	4.80	36.80
CABLES	25.00	3.75	28.75

Mannesmann Tally M80 MC

The two keywords of this printer are reliability and long life. This is a true commercial printer which is ideal for long report generating or constant use. This 80 column device prints bi-directionally at 200 cps, and utilises a 7 x 7 dot matrix as standard. It comes complete with a parallel interface and a 96 character set. You can select from 10 characters per inch and 16.5 characters per inch, each mode has a double width option enabling you to highlight headlines etc.

Price	Nett	Vat	Total
M80 MC	1000.00	150.00	1150.00



Anadex DP 9500 Series

The DP 9500 is designed for all printer applications. It comes complete with three ASCII compatible interfaces, a RS232c, an input that accepts 20/60 ma current drive mode and a centronics input. This is a truly amazing printer with a myriad of features. These features include a high density graphics mode (suitable for APPLE graphics printing), a 600 character buffer, 150-200 cps, programmable horizontal and vertical tabs, self test, 96 characterset, normal, condensed and expanded print, the list seems endless. If you need a high speed, versatile printer, look no further.

Price	Nett	Vat	Total
DP 9500	895.00	134.25	1029.25
DP 9501	995.00	149.25	1144.25
New for 81			
Microline 82	550.00	82.50	632.50
Centronics 737	425.00	63.75	488.75

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apple® computer
Sales and Service

Microdigital Guarantee now extended to **2 years** on all Sharp and Apple hardware purchased after 1.1.81

Microdigital supply a 48k machine for the price of a 16k machine, we supply a Black and White modulator free and give free delivery and twelve month guarantee

Price	Nett	Vat	Total
Apple II Computer 48k	695.00	104.25	799.25

All Apples supplied by us are legitimately imported and are genuine 230V Europlus models.

Disk Subsystem

The latest DOS 3.3 16 sector disk drive with controller, which replaces the old model

Price	Nett	Vat	Total
	383.00	57.45	440.45

Second disk drive uses same controller as first drive.

Price	Nett	Vat	Total
	299.00	44.85	343.85

Language System

This package includes the Language Card, which allows APPLE users to take immediate advantage of the powerful PASCAL language as well as the Integer and Applesoft BASIC interpreters. The Lanuage Card's 16K bytes of RAM memory electrically replace the ROM firmware built into each APPLE. Upon start-up this RAM memory is automatically loaded from disk with the user's choice of languages then electrically protected from change.

Price	Nett	Vat	Total
	299.00	44.85	343.85

Apple Fortran

Apple FORTRAN is "ANSI Standard Subset FORTRAN 77". These latest computer industry standards provide significant additions and enhancements over previous 66 standards (FORTRAN IV). An example of this is the expanded "IF" statements that have been added to traditional FORTRAN statements.

Apple FORTRAN operates in the Apple Pascal Language system offering the same comprehensive software development environment provided to our Pascal programmers. The Editor, Linker, Filer and Assembler can all be used with the Apple FORTRAN compiler, which, like Pascal, produces 'P' code.

Price	Nett	Vat	Total
	120.00	18.00	138.00

MICROSOFT Z-80 Softcard

The Z-80 SoftCard is a plug-in peripheral card for the Apple II that actually contains a Z-80 microprocessor and allows the Apple to run software written for Z-80 based computers. Also included on diskette in the SoftCard package are the CP/M operating system and Microsoft BASIC, the two most significant microcomputer software packages ever developed. All of the features of the Z-80 SoftCard package add up to an incredible value for Apple II owners.

Thousands of Applications

Literally thousands of CP/M-based applications can be easily converted to run with the SoftCard simply by transferring CP/M files from your CP/M source machine to the Apple via a comm line. A utility is included with the SoftCard to facilitate this transfer.

Apple Compatibility

The SoftCard runs with almost every Apple product from the Apple II to Apple II Plus, Language Card and peripherals. Independent peripherals are supported too. A SoftCard software utility lets you transfer Apple DOS files onto a CP/M disk.

Easy Installation

The SoftCard plugs in to any of the Apple's peripheral slots. No hardware modification is required.

Requirements

Apple II or Apple II Plus
48K Memory*
1 Disk Drive
*When used in a 48K machine, 44K of memory is available. When used with a Language Card, 56K is available.

Price	Nett	Vat	Total
	170.00	25.50	195.50

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Cobol

CIS COBOL is a complete software system for compiling, testing, debugging, and executing standard COBOL programs.

It is called CIS COBOL because it is Compact, Interactive, and Standard.

Compact

Standard CIS COBOL runs on systems of 48K bytes and up.

Interactive

CIS COBOL has features specifically tailored to interactive applications – in which the operator communicates directly with the program via a CRT screen and keyboard. It also caters fully for interactive program development.

Standard

CIS COBOL conforms to the ANSI 1974 standard for COBOL, so that programs can be transferred to your system from other computers, or vice versa.

The two principal components of CIS COBOL are the CIS COBOL compiler and the CIS COBOL Run Time System.

Requires Z-80 SoftCard in a 48K system

Price	Nett	Vat	Total
	425.00	63.75	488.75

Forms – 2

Screen formatter/ Program generator

Price	Nett	Vat	Total
	100.00	15.00	115.00

Carrying Case

The Apple is truly portable and this padded vinyl, leather look case protects your Apple in transit and makes it easier to carry.

Price	Nett	Vat	Total
	16.00	2.40	18.40
Dustcover	9.95	1.49	11.44

Appletel

The Appletel package provides the means to bring the Apple II computer and the Prestel service together.

Price	Nett	Vat	Total
	595.00	89.25	684.25

Graphics Tablet

The Graphics Tablet is an image input device that allows the user to enter pictorial information directly (by sketching or tracing) from:

—maps and photographs
—logic diagrams and schematics
—histograms
—architectural drawings
—fine art

Tracing a shape on the tablet surface converts the image to digital values. This information is displayed on the video monitor and may be stored on disk for later processing by the Apple.

Price	Nett	Vat	Total
	462.00	69.30	531.30

DOS 3.3

Apple's new DOS, DOS 3.3, contains two significant improvements for the Apple owner. It creates a compatible environment so that the Apple owner can easily and efficiently use his Applesoft, Integer, and Pascal programes on one set of hardware. The second benefit for the user is that the disk space available is increased 23%. Under the old operating system, approximately 103,000 bytes where available to user. With the new DOS, 126,976 bytes will be available for user programs.

Price	Nett	Vat	Total
	39.00	5.85	44.85

Silentype Printer

The Silentype allows printing of high resolution graphics at 60 dots per inch, at 40 upper/lower case characters per second and 80 characters per line. The Silentype eliminates the loading or writing of a programme to print a screen configuration, because you can dump any high-resolution screen directly to the printer.

Price	Nett	Vat	Total
	349.00	52.35	401.35
10 rolls thermal paper for Silentype	28.00	4.20	32.20
Dustcover for Silentype	9.95	1.49	11.44

Double Vision 80 Column Card

The adapter displays upper and lower case characters and is highly compatible with BASICS and PASCAL. In BASICS, PR# O does not switch off the card, a distinct advantage over some others. A 12" monitor is essential when displaying 80-Columns.

Price	Nett	Vat	Total
	162.00	24.30	186.30
Software to convert to Pascal	12.00	1.80	13.80

Alf Music Synthesiser

Three simultaneous voices
Interactive graphics music entry
Complete, ready to use
Stereo outputs
Pitch, envelope, and volume
Expandable to 6 or 9 voices.
No "music languages" to learn
Full piano range
No tuning required
Save and load songs

Price	Nett	Vat	Total
	95.00	14.25	109.25
Timing Mode Input Board	14.00	2.10	16.10
Alf Music Album O (Xmas)	12.00	1.80	13.80
Alf Music Album 1	12.00	1.80	13.80
Alf Music Album 2	12.00	1.80	13.80

Apple Cards

Parallel Printer Interface

The Parallel Printer Interface Cards are available to allow the use of parallel printers with your APPLE computer.

Price	Nett	Vat	Total
Parallel	104.00	15.60	119.60
Centronics	130.00	19.50	149.50

Communications Interface Card

The Communications Interface Card is available separately to allow you to connect your APPLE to modems, CRT terminals, and other devices employing a serial RS-232C interface. The card's built-in intelligence lets you control these devices easily, in BASIC.

Price	Nett	Vat	Total
	130.00	19.50	149.50

Eurocolour Card

Produces PAL colour signals to drive colour video monitor or with a Black & White modulator drives a colour T.V.

Price	Nett	Vat	Total
	113.00	16.95	129.95

Hobby/Protyping Card

Create your own APPLE interface boards with this wire-wrap card. The 2¾" x 7", double-sided circuit board includes a hole pattern (on 100-mil centres) that accepts all conventional IC's and passive components. It plugs directly into any APPLE expansion

(Continued overleaf)

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connector, and fits entirely within the computer case. Supplied with complete bus documention to aid the interface designer.

Price	Nett	Vat	Total
	15.00	2.25	17.25

Serial Interface

The Serial Interface Card allows an APPLE computer to exchange data with computers, printers, and other devices in serial format (one bit at a time). It is intended for use (in place of the Communications Interface Card) in applications that:
—Use data rates other than 110 or 300 baud (10 or 30 char/sec)
—Involve serial printers that don't require "handshake".

Price	Nett	Vat	Total
	113.00	16.95	129.95

Heuristics

Heuristics

Speechlink Model H2000

A practical low-cost speech recognition peripheral for the Apple® computer that allows you actually to talk to your Apple-

- to enter data.
- to control programs and the disk.
- to control other equipment attached to the Apple.

The H2000 substitutes your voice for the keyboard. It enables you to think and control your computer at the same time, concentrating on the action — the video display, printer output, or external action under computer control.

Features

- Recongnize 64 words or phrases of your choice on the Apple® computer.
- Link more than one set of 64 words to provide essentially unlimited vocabulary.
- Write your programs in BASIC (no assembly language coding required).
- Use it with Applesoft® Floating Point BASIC or Integer BASIC (Extendable to Pascal).
- Requires only 4K RAM to recognize 64 words or phrases.
- Run under Disk Operating System or Cassette Tape System.
- Small pre-trained vocabulary facilitates system use.
- Complete with microphone, manual, demonstration software, and one year warranty.

Price	Nett	Vat	Total
	168.00	25.20	193.20

Model 70 controller

Provides four relay contact-closure outputs on a card which plugs into an Apple® II peripheral slot and which is completely controlled by POKE statements in Apple® II BASIC. The unit is recommended for use with Heuristics™ SpeechLab® and SpeechLink™ voice data and control input cards for the Apple® II, but may be used with any Apple® in any application. More than one Model 70 may be used in an Apple®.

Price	Nett	Vat	Total
	57.00	8.55	65.55

Speechlab Voice Recognition Card

Allows the Apple to recognise a spoken vocabulary of up to 32 user-selected words. The computer can be programmed to perform any task desired upon recognition of a key word.

Price	Nett	Vat	Total
	122.00	18.30	140.30

Mountain

Mountain Hardware, Inc.

Clock/Calendar Card

This plug-in card provides a 388-day calendar and clock, with resolution to 1/1000 second. The clock is crystal controlled to yield .001% accuracy. A built-in rechargeable battery keeps the clock on time up to four days without system power, and external batteries may be used for longer periods. Optional interrupt capability simplifies control applications. Supplied with complete operating instructions and rechargeable battery.

Price	Nett	Vat	Total
	168.00	25.20	193.20

ROM Plus card

ROMPLUS + provides six sockets to accept individually addressable 2K ROM's or EPROM's. Keyboard Filter a 2K ROM program, comes installed on the ROMPLUS + board and adds many useful features to your Apple, including:

- Upper and lower case letters. The only system that offers keyboard input and standard shift key operation.
- Multiple user-defined character sets.
- Coloured or inverse-coloured letters.
- Keyboard macros — two key-stroke, automatic typing of multiple, user-defined words or phrases. Including BASIC and DOS commands.
- Mixed text and graphics.
- Improved cursor control.
- STOP LIST and END LIST.

Price	Nett	Vat	Total
	105.00	15.75	120.75

Copyplus ROM

For use with ROM Plus Card.

Price	Nett	Vat	Total
	30.00	4.50	34.50

Supertalker

Give voice to your Apple

SuperTalker allows you to add the dimension of human speech output in your computer programs. Add voice to games. Program verbal prompting for the operator of your business system. Use verbal warnings under program control as an enunciator in commercial security or control rooms. Create educational programs that verbally coach the student.

The SuperTalker system

SuperTalker is a new peripheral system which allows the Apple II computer to output exceptionally high quality human speech through a loud-speaker under program control. Output may also be directed through any P.A. or stereo system. Initially, spoken words are digitized into RAM memory through the system microphone. Speech data in RAM may then be manipulated like any other stored data.

A complete package

The SuperTalker peripheral system consists of: The SuperTalker peripheral card which plugs into a peripheral slot on the Apple II; a microphone; a loudspeaker; easy-to-use operating software and documentation; plus, two ready-to-run SuperTalker programs.

Price	Nett	Vat	Total
	179.55	26.93	206.48

Romwriter

Hardware:

- Programs 2716 EPROMs—5V, 2K.
- Installs in any peripheral slot (except # 0).
- Zero insertion force socket. (ZIF). Mechanical lever opens up pin holders to drop in an EPROM.
- On-board Bat Handle switch for power off to ZIF Socket permits EPROM to be Installed/Removed without power-down of computer.
- On-board DIP switch provides:
  Write Protect—provided to prevent accidental overwriting of EPROMs while RUNing for RomWriter. $CFFF-Off-provided to suppress execution of this command (which shuts off all peripherals in the Apple system when executed) while programming or later while RUNning.

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Unmatched flexibility and versitility from the world's best selling computer.

- Programmed EPROMs can be RUN while residing on RomWriter board.
- Optimum voltage and current for trouble-free programming.
- Complete 2716 programmed in under 2 minutes (50 msec/byte).

Price	Nett	Vat	Total
	106.05	15.91	121.96

Musicsystem

This 16 voice digital synthesizer is said to set new standards for computer generated music. Its capabilities permit the creation of the sounds of real musical instruments utilizing the principle of additive synthesis . The generation of sounds is accomplished through fully programmable waveforms, envelopes, and amplitudes for each musical "voice". Provided with the hardware system is software for editing and playing of musical compositions. The Editor program permits graphical input of sheet music utilizing standard music notation. The Player program permits polyphonic performance of musical compositions. Stereo output is to users' stereo amplifier and speakers, or directly off card with stereo headphones.

MusicSystem generates the sound of any musical instrument – real or imagined – solo or sextex – rock or classical – at home or in the concert hall or classroom! MusicSystem permits virtuoso performance in computer generated music never possible before outside of research and development labs, and is a real breakthrough in low-cost music generation.

Price	Nett	Vat	Total
	312.00	46.80	358.80

California Computer Systems

Asynchronous Serial Interface

Price	Nett	Vat	Total
	106.00	15.90	121.90

Synchronous Serial Interface

Price	Nett	Vat	Total
	119.00	17.85	136.85

Parallel Card

Price	Nett	Vat	Total
	79.00	11.85	90.85

Arithmetic Processor Unit

Price	Nett	Vat	Total
	265.00	39.75	304.75

IEEE/GPIB Interface

Price	Nett	Vat	Total
	199.00	29.85	228.85

Programmable Timer

Price	Nett	Vat	Total
	106.00	15.90	121.90

A/D Converter

Price	Nett	Vat	Total
	99.00	14.85	113.85

ROM/PROM Module

Price	Nett	Vat	Total
	70.00	10.50	80.50

Centronics Card

Price	Nett	Vat	Total
	79.00	11.85	90.85

Clock Card

Price	Nett	Vat	Total
	83.00	12.45	95.45

Interactive Structures D109 Universal Digital Interface

Description

The D109 is a complete digital interface system on a single Apple II card. Plug it in and take control of 32 data lines, each one usable by your software as an input or an output. Add a current driver and operate relays or light bulbs directly. Add an isolation card and you're set to operate in the most hostile of industrial environments.

Use the on-board timers to count events, generate precise square wave, or interrupt your program when it's time for lunch. Combine the timers to measure up to 17 years. Use them individually to measure microseconds.

Set the D109 to interrupt you for any of 14 different reasons. Use the control lines to shake hands with other equipment when you have data to exchange. If you have 8 bits but only one wire, serialize with the built-in shift registers.

The D109 is a powerful new member of the Applecations (tm) Series. Plug it in and build a system that will surprise a few people.

Features

- 32 digital input or output lines.
- 4 programmable timers
- 2 shift registers.
- full interrupt capability.
- optional current drive and isolation.
- single Apple II card.

Price	Nett	Vat	Total
	213.00	31.95	244.95

A1 – Ø2 Analog Converter Card

What is the A1-Ø2

The A1-Ø2 is a single card system which allows Apple II* to look at analog, or non-digitized information. This means that the Apple can sample temperature, measure light level, or listen to sound, and use the result as an input to a program. Since most of the quantities of interest in controlling a home environment or an industrial process are analog quantities, this opens a very large set of new applications to the Apple user.

Analog Information

The A1-Ø2 accepts information in the form of an analog voltage level in the range of Ø to 5.ØØ volts. Depending on the sensor used, this will corespond to a range of values such as Ø°F to 212° or 5lbs. to 15lbs. of pressure.

Input Channels

The A1-Ø2 provides 16 separate channels for input. One channel at a time is selected by the program, and the voltage present at the input when it is selected is the value returned to the program. There are no restrictions on the use of inputs: one may be selected repeatedly, all 16 may be selected in sequence, etc.

Price	Nett	Vat	Total
	192.00	28.80	220.80

A0 – 03 Analog Output Board

General Description

- Up to 8 independent channels.
- Each channel digitally latched.
- Range and offset adjustable.
- Monotonic.
- Accurate to 1/2 LSB.

The AO-03 Analog Output system is a multi-channel interface between the Apple-II* microcomputer and the analog world. Using the AO-03 card, a BASIC or Assembly language program can, in a single operation, set or change an analog voltage level. Up to eight channels may be controlled, with the outputs being truly parallel, latched digitally on the AO-03. Resolution of the digital-to-analog conversion is 8 bits and the output will settle to within one-half LSB in 2 microseconds. The AO-03 is ideal for controlling light level, producing music, and deflecting CRT, Plotter or LASER graphics systems.

(Continued overleaf)

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Apple II

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Analog Outputs

Each output channel of the AO-03 is buffered and short circuit protected. The output range of voltages correspond to the binary codes thru 255. Each channel is individually adjustable for range and zero adjust. A strap may be inserted to shift from the standard positive voltage range to a bipolar range. Space is also provided for addition of components to smooth the output transitions for the lower bandwidth applications.

Price	Nett	Vat	Total
4 Channel	180.00	27.00	207.00
8 Channel	281.00	42.15	323.15

Other Prices

Price	Nett	Vat	Total
Applesoft firmware card-for integer apples.	116.00	17.40	133.40
Integer Card – for applesoft apples	116.00	17.40	133.40
Programmers Aid I	27.00	4.05	31.05
Auto-Start ROM Pack.	38.00	5.70	43.70
Apple Juice Back up power supply.	157.00	23.55	180.55
Templeman dual 8" disk system. – 1M byte.	1550.00	232.50	1782.50
Apple Desk – Two Tier.	145.00	21.75	166.75
Apple Desk – Two Tier (Economy).	125.00	18.75	143.75
Printer Table.	92.00	13.80	105.80
Printer Table (Economy).	87.00	13.05	100.05
Single Tier Apple Desk.	48.00	7.20	55.20

Documentation

	No. VAT £
Apple II Reference Manual	11.00
6502 Hardware Manual	9.00
6502 Software Manual	9.00
Apple II Basic Programming Manual	6.00
Applesoft II Reference Manual	6.00
DOS 3.2 Manual	6.00
Apple II Basic Tutorial Manual	6.00
Autostart ROM Manual	4.50

Apple Software

All supplied on disk, unless otherwise specified.
Where integer basic is required this can be either:

1. An integer Apple.
2. An Apple II + with integer card.
3. An Apple II + with relocated integer.
4. An Apple with language system.

Business Tools

CCA DATA MANAGEMENT (48K APPLE, Disk)

This system, developed by Personal Software, stores and retrieves information. It is very simple to learn and use, and at the same time provides real data processing capabilities for you and your Apple. Allows you to prepare and access files for your mailing list, customer lists, expense reporting, budget analysis or any report you need.

Price	Nett	Vat	Total
	75.00	11.25	86.25

DESK TOP PLANNER (48K APPLE, Disk)

A unique financial planning and forecasting system that is driven by a simple menu system. Allows you to create business models or sub-models and build up consolidated summaries if you have individual branches or cost centres. A best selling package available for the first time in the U.K.

Price	Nett	Vat	Total
	75.00	11.25	86.25

VISICALC (32K APPLE, Disk)

Visicalc provides an electronic worksheet of up to 63 columns and 254 rows. At the juncture of any column and row you can type in words or numbers. Where you want the worksheet to perform a calculation, you type the formula. Visicalc automatically performs all arithmetic functions and instantly displays all of the results. If you change any of the numerical data, the electronic worksheet instantly displays a new result – automatically. Anyone who works with numbers – managers, financial analysts, accountants, engineers and scientists – will find Visicalc essential for their personal computer. Voted program of the year in the U.S.A.

Price	Nett	Vat	Total
	125.00	18.75	143.75

Apple Plot

A useful addition to VisiCalc and Desktop/Plan systems which enables results to be plotted quickly and accurately. Multiple sets of data can be compared on the same report and displayed on the screen, in colour, or a hard copy generated for reports, files etc. Apple Plot can be used independent of Visicalc and Desktop/Plan.

Price	Nett	Vat	Total
	37.00	5.55	42.55

Apple Writer

Most probably the best word processing system available on a microcomputer for the price. Features include, fast easy cursor control, moving blocks of text, delete by character, word, and paragraph, search and replace, left right centre text justification.

Price	Nett	Vat	Total
	42.00	6.30	48.30

Estate Agents

Developed in conjunction with a leading firm of Chartered Surveyors and Estate Agents, the system is a cost-effective aid to residential property sales which quickly matches the property and applicants vice versa.

Price	Nett	Vat	Total
	500.00	75.00	575.00

Mailing List

This system is a complete name, address and reference recording and management system for use in a wide variety of business operations. Up to 375 records can be held on each floppy disk. Features include add/amend/delete record, print records, print labels and various sort/selection facilities.

Price	Nett	Vat	Total
	70.00	10.50	80.50

Games and Simulations

INVASION ORION (32K APPLE, Disk)

A complete tactical science fiction war game that provides you with scenarios designed to allow players of different skills to find a challenging game of space warfare every time. Choose from three levels of play for the computer. You can allow the computer to play either side.

Price	Nett	Vat	Total
	18.00	2.70	20.70

MICROCHESS (16K APPLE, Disk)

Perhaps the most famous chess game of all Peter Jennings latest version written in machine code. It displays a graphic chess board and uses standard algebraic notation to describe the moves. You may set up special board situations and play them out against the computer "Should be well received at the low asking price" –Computing Today.

Price	Nett	Vat	Total
	15.00	2.25	17.25

STAR FLEET ORION (32K APPLE + INTEGER ROM CARD, Disk)

This program brings you the opportunity to fight space battles in your living room. 12 scenarios are provided in the game. These are of varying complexity with 2 to 15 spacecraft and playing times from 15 minutes to 6 hours. Starfleet Orion also includes a Rule Book, Battle Manual and Ship Control Sheets.

Price	Nett	Vat	Total
	18.00	2.70	20.70

TEMPLE OF APSHAI (48K APPLE, Disk)

This is a fantasy adventure, but goes far beyond any other fantasy adventure game you may have seen for microcomputers. There are over 200 rooms, chambers and passages and over 30 different kinds of monsters guard the many and varied treasures of Apshai. You'll spend hours or days wandering the ruins. "The Temple of Apshai is quite an experience. I am very pleased with it and rate it as one of my favourite PET programs." Len Lindsay – COMPUTE.

Price	Nett	Vat	Total
	22.95	3.44	26.39

APPLE INVADERS (48K + PADDLES)

An excellent representation of the famous arcade game "Alien Invaders." Very competitive game with remarkable hi resolution graphics and high scoring. Good luck!

Price	Nett	Vat	Total
	12.00	1.80	13.80

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Apple Software

STAR VOYAGER (32K + INTEGER ROM CARD + PADDLES)

A most challenging adventure in three parts. First destroy the evil emperor's city, Secondly dock with a military space station and finally defend youself against space pirate ships. A three in one bargain.

Price	Nett	Vat	Total
	15.95	2.39	18.34

SUPER STARWARS (32K + INTEGER ROM CARD JOYSTICK OR PADDLES)

Very realistic galactic battle with "floating sights" adding a very high degree of professionalism to a most acclaimed computer battle game.

Price	Nett	Vat	Total
	11.25	1.69	12.94

CHECKER KING (16K APPLE, Disk)

Peronal Software's Checker King lets you play against your computer at eight levels of difficulty. A unique feature allows you to store, in memory, up to three board situations and replay them. All moves on the draughts board are naturally checked for legality.

Price	Nett	Vat	Total
	17.50	2.63	20.13

DATESTONES OF RYN (48K APPLE, Disk)

A dastardly robber band led by the notorious rogue, Rex the Reavers, has stolen the precious Datestones. Your mission is to recover the Datestones before Rex and his cut-throats slip away. The Datestones of Ryn comes as a complete package, ready to play, including game program, 1200 Byte data file and 16 page manual.

Price	Nett	Vat	Total
	12.95	1.94	14.89

GAMMON GAMBLER (16K APPLE, Disk)

Become a Backgammon expert fast, Gammon Gambler provides ten levels of skill, from beginner to expert. The ideal way to learn or polish your game, because Gammon Gambler checks all of your moves for legality, lets you back up and correct your move, and optionally displays the number of points. Backgammon rules are included in the manual.

Price	Nett	Vat	Total
	15.00	2.25	17.25

Programming Aids

ASSEMBLER EDITOR (48K)

A two pass assembler which is a compatible subset of the Fortran cross assemblers available for 6500 series micros. This package incorporates the APPLEPIE text editor to facilitate preparation of source code for assembly. Machine instruction source statements provide mnemonics codes for all machine instructions in the 6500 series instruction set. File linkage facility allows simultaneous assembly of multiple source files.

Price	Nett	Vat	Total
	45.00	6.75	51.75

DISK MAGIC (48K + INTEGER ROMCARD)

An invaluable programmer's utility. Enables the user to read and write information at the sector level without the constraints of the normal disk operating system. Repair damaged files, "undelete" files, instant report of free space available.

Price	Nett	Vat	Total
	16.00	2.40	18.40

HI-RESOLUTION CHARACTER GENERATOR (48K + INTEGER ROMCARD)

The program gives unlimited potential for intricate designs; animation can be displayed with a faster speed compared to using normal routines. The memory used is half that of using the normal hires routines. Each character set is 96 characters and two sets can be accessed by the key board at one time – that is 192 accessible characters and even more can be used, allowing as many sets as your memory permits.

Price	Nett	Vat	Total
	16.50	2.48	18.98

APPLEFORTH (16K + INTEGER ROMCARD)

A fast, interactive, compact language originally developed by astronomers for the control of their instruments. Run time overhead of only 70-100% compared with around 1000% for Applesoft interpreter. Software development times are also much shorter than for Assembler programming. Appleforth runs stand – alone using the APPLE's onboard monitor for I/O.

Price	Nett	Vat	Total
	39.95	5.99	45.94

LARGE CHARACTER (32K + INTEGER ROMCARD)

Uses low-res graphics to display a message of up to 33 pages long. Each page contains three lines of up to six letter/numbers in colour. Ideal for point of sale advertising and display.

Price	Nett	Vat	Total
	16.00	2.40	18.40

LISA (48K + INTEGER ROMCARD)

A powerful assembler. Symbolic and non-symbolic addressing modes, indexing and pseudo operation codes. A most essential tool.

Price	Nett	Vat	Total
	28.50	4.28	32.78

MASTER CATALOGUE (32K)

An alphanumeric sorting and filing program. It makes full use of the Ampersort routine as described in leading magazines, will enable the user to delete a file, add a volume, list file, sort by program name, sort by volume, find a program. Once you have more than one program diskette it is iresistible.

Price	Nett	Vat	Total
	14.00	2.10	16.10

SHAPE BUILDER (48K)

Brings hires graphics within reach of those unwilling to work with binary or hexodecimal. Gives full control over shape rotation and colour and is probably the best hires shaper available on the market.

Price	Nett	Vat	Total
	17.00	2.55	19.55

TINY PASCAL (32K)

This language is integer only unlike full Pascal. It is compatible with Integer Basic and APPLESOFT; all of these languages can reach in, manipulate, and write out to each other. Tiny Pascal includes very comprehensive documentation and programming examples. As favourably reviewed in BYTE magazine in America.

Price	Nett	Vat	Total
	40.00	6.00	46.00

LISP

The system consists of 6k bytes of machine code interpreter plus 4k bytes of initialised LISP workspace containing LISP utilities and constants. It is supplied on disc with a 44 page manual for a 16k or larger computer. Two demonstration programs are included. The system has been designed with ease of use in mind.

The fast compacting garbage collector automatically finds space for numbers, lists or character strings if there is any space at all remaining. This means that the programmer need never be concerned about the details of storage allocation. Supplied on Disk. Requires 32K System.

Price	Nett	Vat	Total
	58.00	8.70	66.70

Scientific

INDEX FILE (48K + INTEGER ROMCARD)

Provides facilities for new files, accessing data on existing files, recovering record details, adding records, deleting records and modifying records. Also contains text string search facility.

Price	Nett	Vat	Total
	16.00	2.40	18.40

FUNCTION PLOT (48K)

The program plots two dimensional functions using hi-resolution graphics. The functions can be simple or complicated and assists visualisation of types of co-ordinate systems. Plots rectangular or polar co-ordinates. Rectangular co-ordinates can be linear, logarithmic or semi logarithmic. Axes are clearly labelled and several examples are shown within the program.

Price	Nett	Vat	Total
	18.50	2.78	21.28

STATISTICS (24K)

A pack of six programs allowing the following statistical tests: Mean, Variance and Standard Deviation, Binomial, Normal Distribution Probability and Frequency, chi-Square Distribution, chi-Square Test and T-Test. A practical business aid that is very simple to execute.

Price	Nett	Vat	Total
	19.95	2.99	22.94

Tutorials

STEP BY STEP (32K)

The famous basic tutorial for the APPLE. Comes complete with a sixty page manual. Ideally suited to the first time user and beginner. Its method of teaching will ensure that programming skills quickly become habit.

Price	Nett	Vat	Total
	25.00	3.75	28.75

Maths Sequences

A comprehensive software curriculum in mathematics for children aged 5-10. Topics covered range from simple arithmetic through to laws of arithmetic and negative numbers. Instruction is completely individualised based on each student's needs and abilities. The programs are success orientated and allow the student to work at his own pace towards set objectives. As well as all this each student's progress is monitored thus allowing the teacher to review the progress of all students in a matter of minutes.

Price	Nett	Vat	Total
	200.00	30.00	230.00

Other Software

Price	Nett	Vat	Total
Contributed Software 1-2	27.00	4.05	31.05
Contributed Software 3-5	60.00	9.00	69.00
Disc utility pack	15.00	2.25	17.25
Apple Post	27.00	4.05	31.05
Apple Bowling	9.00	1.35	10.35
Stellar Invaders	13.00	1.95	14.95
Apple Adventure	21.00	3.15	24.15
Checker King	15.00	2.25	17.25
Bridge Partner	14.00	2.10	16.10

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SYBEX BOOKS

Introduction to Personal and Business Computing by R. Zaks 4.90
A comprehensive yet simple introduction to the micro computer world for the potential user whether it be for home or business use.

Microprocessors – From Chips to Systems by R. Zaks 6.95
The basic text on micros for everyone with a technical or scientific background. This book teaches all the fundamentals of microprocessors step by step.

Microprocessor – Interfacing Techniques by R. Zaks 9.90
This comprehensive book introduces the basic interfacing concepts and techniques, then presents the implementation details from hardware to software.

Programming the 6502 by Rodnay Zaks 7.90
This book is an educational text designed to teach programming, using the 6502. It does not require any prior programming knowledge, yet can be used to advantage by anyone wishing to familiarize himself with the 6502. An invaluable book for owners of the PET, Apple, Kim etc

6502 Applications Book 7.90
This book presents practical applications techniques for the 6502 ranging from a complete home alarm system to an industrial control loop for temperature control. Also includes analog to digital conversion and simple peripherals from paper-tape reader to micro printer.

Programming the Z-80 8.90
Another in the highly successful Sybex Series by Rodnay Zaks. This book combines the function of a teacher text, that Sybex do so well, with an extensive reference section. The book is much more than an introduction to the Assembly Language syntax of the Z-80.

Your First Computer by Rodnay Zaks 5.90
A Basic introductory text on small computers. Clear, detailed explanations of what a computer system is, what it can do, how it works and how to select the various components and peripheral units. Comprehensive discussions on programming a computer, recent language developments (CP/M and PASCAL), the newest hardware and buying a system wisely. Includes in particular a detailed discussion of peripherals. Designed as a reference guide as well as an introduction to small computers.

The CP/M Handbook by Rodnay Zaks 8.90
CP/M – the industry standard in operating systems. Now SYBEX makes CP/M as easy to use as ABC with this new step-by-step guide. This book teaches the reader to use the editor and assembler to create, copy and modify files. It offers a clear understanding of CP/M's basic operation, then explores all versions of CP/M, including CDOS and multi-user MP/M. A general overview, sample programs, practical operating hints and numerous handy reference tables, make the CP/M HANDBOOK a must for anyone using or considering CP/M – from input typists with no computer background to experienced applications programmers.

Programming the Z8000 by Richard Mateosian 7.90
This book describes, in detail, the architecture and function of the Z8000 and its family of support chips. It provides an introduction to machine language programming using the Z8000 and presents many sample Z8000 programs to illustrate programming techniques and designs principles. It even shows how clear, well-organised programs can be written for complicated subjects like interrupt I/O programming and timesharing. It is intended for anyone interested in the Z8000; the electronic design engineer, the advanced programmer or the beginner. PDP-11 users should find it especially interesting since the step from a PDP-11 system to a Z8000 system is a relatively easy one.

OSBORNE BOOKS

Practical Basic Programs 9.90
Every program – and there are 40 programs in all – is presented with a verbal description, BASIC source listings, sample run, practice problems, and operating instructions. These short programs address management decision-making, financial, statistical, mathematical and scientific problems. It's a program recipe book, and you don't have to be a programmer to appreciate it.

Z-80 Assembly Language Programming 8.10
These books are assembly language primers in the "classical sense" – they treat assembly language as a means of programming a microcomputer system and are full of simple programming examples.

6502 Assembly Language Programming by Leventhal 8.20
Another fine manual in the Osborne Assembly Language series to join the best selling 8080, 6800 and Z-80 books.

PET and the IEEE 488 Bus (GPIB) by Fisher & Jenson 9.90
A book for instrument designers, scientists, programmers and hobbyists – which shows how you can have a low-cost versatile system that may be interfaced to any of hundreds of electronic instruments.

Introduction to Microcomputers by A. Osborne – Volume 0: The Beginners Book 5.90
If you know nothing about computers this is the book to begin with. It explains what computers are and describes their components.

Introduction to Microcomputers by A. Osborne – Volume 1: Basic Concepts 6.25
This book describes application techniques common to all microprocessors yet specific to none. All the basic hardware and software concepts are explained simply.

Introduction to Microcomputers – Osborne (September 1978 Edition) Volume 2 – Some Real Microprocessors 14.90
This 9" x 7" loose leaf format book covers every major microprocessor on the market. 4 bit to 16 bit in detail and analyses more than 20 CPUs. Includes new sections on the most recent entries into the microprocessor market. Describes support devices for use with only one microprocessor.

Volume 3 – Some Real Support Devices – loose leaf 10.90
A companion volume to volume 2. This describes the micro support devices which can be used with more than one microprocessor – including system buses.

Some Common BASIC Programs 7.90
Includes 76 short programs covering financial, mathematical, statistical and general interest subjects, all of which have been tested.

Z-80 Programming for Logic Design 6.25
These books describe the implementation of sequential and combinational logic using assembly language. They describe the meeting ground of the programmer and the logic designer and are written for readers in both fields.

HOWARD SAMS BOOKS

Microcomputer Primer by M. Waite and M. Pardee 6.30
Written for the beginner in the computer field. All the basic concepts and characteristics of microcomputers are explored and explained.

Getting Acquainted with Micros by L. Frenzel 6.90
Learn about microcomputers in an effective low cost manner. The essential information contained in this book has been compiled especially for Engineers, Technicians and Scientists but is equally invaluable to the layman.

Computer and Programming Guide for Engineers by D. Spencer 9.10
Written specifically for the Engineer or Scientist, this book explains what a computer is, how it works and how it can be used to the best advantage. Details FORTRAN and BASIC programming.

TTL Cookbook by D. Lancaster 7.10
Discover what transistor-transistor logic is, how it works and how to use it. Discusses practical digital applications and teaches you how to build TTL systems that entertain test and train.

CMOS Cookbook by D. Lancaster 7.45
Your complete guide to the understanding and use of Complementary Metal-Oxide-Silicon integrated circuits. Gives usage rules, power supply design examples, applications, bread boarding and coverage of logic.

TV Typewriter Cookbook by D. Lancaster 7.20
A comprehensive guide to low cost television display of alpha-numeric and graphics data for microprocessor systems word processing, TV teling and video games.

Cheap Video Cookbook by D. Lancaster 4.90
A complete guide to super low cost alphanumeric and graphic microprocessor based video displays – this book picks up where the TV Typewriter Cookbook ended.

How to Program Micros by W. Barden Jnr. 6.90
Explains assembly language programming of microcomputers based on the 8080, 6800 and 6502 microprocessors. Basic concepts, number systems and operations, computer operation and codes are examined.

Z-80 Microcomputer Handbook by W. Baden Jnr. 6.90
This book provides essential information on Z-80 technology and is organised into three sections: Hardware, software and microcomputers built around the Z-80.

Microcomputers for Business Applications by W. Barden Jnr. 7.10
This book will prove invaluable to a potential buyer of a business microcomputer system – helping him to select the best system for his particular needs. The micros discussed range from spin-offs of hobbyist computers to complete "turnkey" systems with customised software.

The S-100 and Other Micro Buses by Poe and Goodwin 5.10
This book is about buses and after acquainting the reader with bus basics moves on to detail the eleven most widely used bus systems.

BASIC Primer by Waite and Pardee 6.90
This book is exactly what it says it is – on top of this it also includes 7 appendices to help you optimise your code for speed or memory use. Finally at the back is a reference card which you will keep in your pocket during the rest of your BASIC programming career.

Z-80 Microprocessor Programming and Interfacing Volume 1 by Nichols and Rony 7.70
This book is the first of a two volume series on the Z-80. It covers programming at the assembly and machine language level for the Z-80. Book 2 will cover interfacing. The books are laboratory oriented texts. The strong emphasis is on learning through experiment. This book requires no background in computers.

Z-80 Programming and Interfacing Book 2 by Nichols and Rony 8.45
Address interfacing digital circuits with the Z-80 CPU, PIA and CTC chip and progresses on from Book 1 (Interfacing) assuming the reader is familiar with the topics covered in Book 1.

Industrial Process Control Systems by Patrick and Fardo 8.90
Process control procedures, system concepts, components, industrial applications and study questions in a logical text book.

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Books

TRS-80 Interfacing by J.A. Titus 6.90
Requiring a good understanding of Level II BASIC, this book describes the signals available in the TRS-80 computer and their applications to the control of external devices. Experiments in the construction and use of some typical interfaces are included.

The Howard W. Sams Crash Course in Microcomputers by L. E. Frenzel 10.60
Written in a teach yourself format with study questions, this book provides a solid background in microcomputers quickly and effectively. All aspects from fundamentals and operating systems to programming and peripherals.

Computer Graphics Primer by M. Waite 8.90
Instruction in the methods of producing drawings, plans, maps and schematics on a CRT. display. In 3 sections, 'Perspectives', 'Basic Concepts' and 'Graphics Programming'.

6502 Software Design by L. Scanlon 7.90
Fundamentals of 6502 operation are explained and then extended to give a comprehensive coverage of 6502 use.

Z-80 Microcomputer Design Projects by W. Barden Jnr. 9.10
A solid introduction to the Z-80 microcomputer and the EZ-80 chip. Simple construction of the EZ-80 microcomputer and several applications.

BUTTERWORTH BOOKS

Basic BASIC by J. Coan 6.45
One of the most widely sold text books on BASIC. The book uses over 100 example problems to illustrate the essential techniques of the language.

Advanced BASIC by J. Coan 5.95
Develops the readers expertise with BASIC through strings and files to graphing and more important mathematical functions.

FORTRAN Fundamentals – A Short Course by Jack Steingraber 3.40
A fast and efficient guide to FORTRAN – providing an abbreviated means of learning the language. Sample problems and their solutions are included.

Programming for Microprocessors by Andrew Colin (hardback) 3.40
This book has been written for those converting from other disciplines to the use of microprocessors. It is designed to allow fast progress to a useful working understanding of the application of microprocessors and includes sections on number representation.

Sargon: A Computer Chess Program by Dan and Kathe Spracklen 9.45
Here is the computer chess program that won first place in the first chess tournament at the 1978 West Coast Computer Faire. It is written in Z-80 assembly language using the TDL macro assembler. It comes complete with block diagram and sample printouts.

The Systems Analyst by J. Attwood (Hardback) 7.45
From the initial decisions whether or not to be use a computer for a specific problem, to the actual installations of the completed system, the book covers the strategies, skills and techniques needed. Written without complex maths it is a step by step guide for people developing systems for the business world.

How to build a Computer-Controlled Robot by Tod Loofbourrow 5.90
Every step of the construction of "Mike" is explained with photographs and diagrams to direct you through the construction. The complete control programs for a robot are clearly written out. You may use the directions exactly as they are set forth in the book or as a basis for devloping your own design. "Mike" can be built within the budget of the average hobbyist and the only technical requirement for building him is the ability to read and understand a circuit diagram.

How to Profit from your Personal Computer – Professional, Business and Home Applications by T. G. Lewis 5.45
Written for business people and computer hobbyists contemplating business applications, it shows how to put your computer to work for you. It describes common business applications such as accounting, handling payroll, managing inventory, sorting mailing lists and many others.

FORTRAN with Style 4.70
A little book to allow you to write professional and well laid out FORTRAN programs.

BASIC with Style 3.90
This type of book is sorely needed by us all as we develop our understanding of BASIC, so that we may adopt some of the disciplines needed to make robust readable programs.

Game Playing with BASIC by D. Spencer 5.45
A non technical book which includes an appreciation of the rules, structure and output for each example discussed.

Sixty Challenging Problems with BASIC Solution 5.90
Contains 60 games, puzzles, mathematical, science and business problems for reinforcing computer programming skills in the BASIC language.

Problems for Computer Solution 5.10
821 problems are arranged by topic ranging from mathematical disciplines to science and business.

CREATIVE COMPUTING BOOKS

Computers in Mathematics A Sourcebook of ideas edited by David H. Ahl 10.90
One section presents over 250 problems, puzzles and programming ideas, more than are found in most "problem collection" books. Pragamatic, ready to use, classroom tested ideas are presented for everything from the most basic introduction to binary numbers to advanced techniques like multiple regression analysis and differential equations. Every item discussed has a complete explanation including flowcharts, programs, and sample runs.
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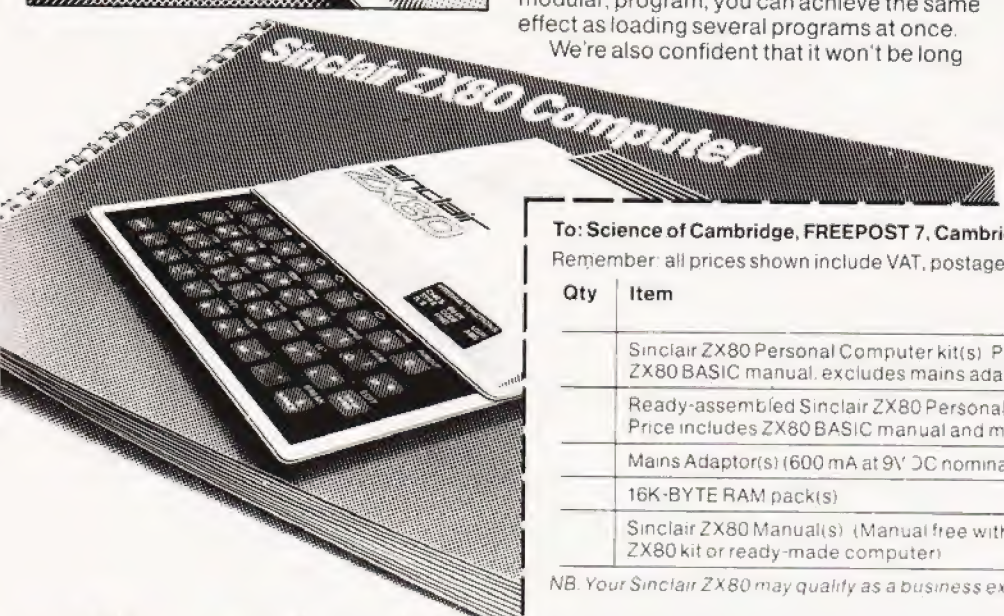

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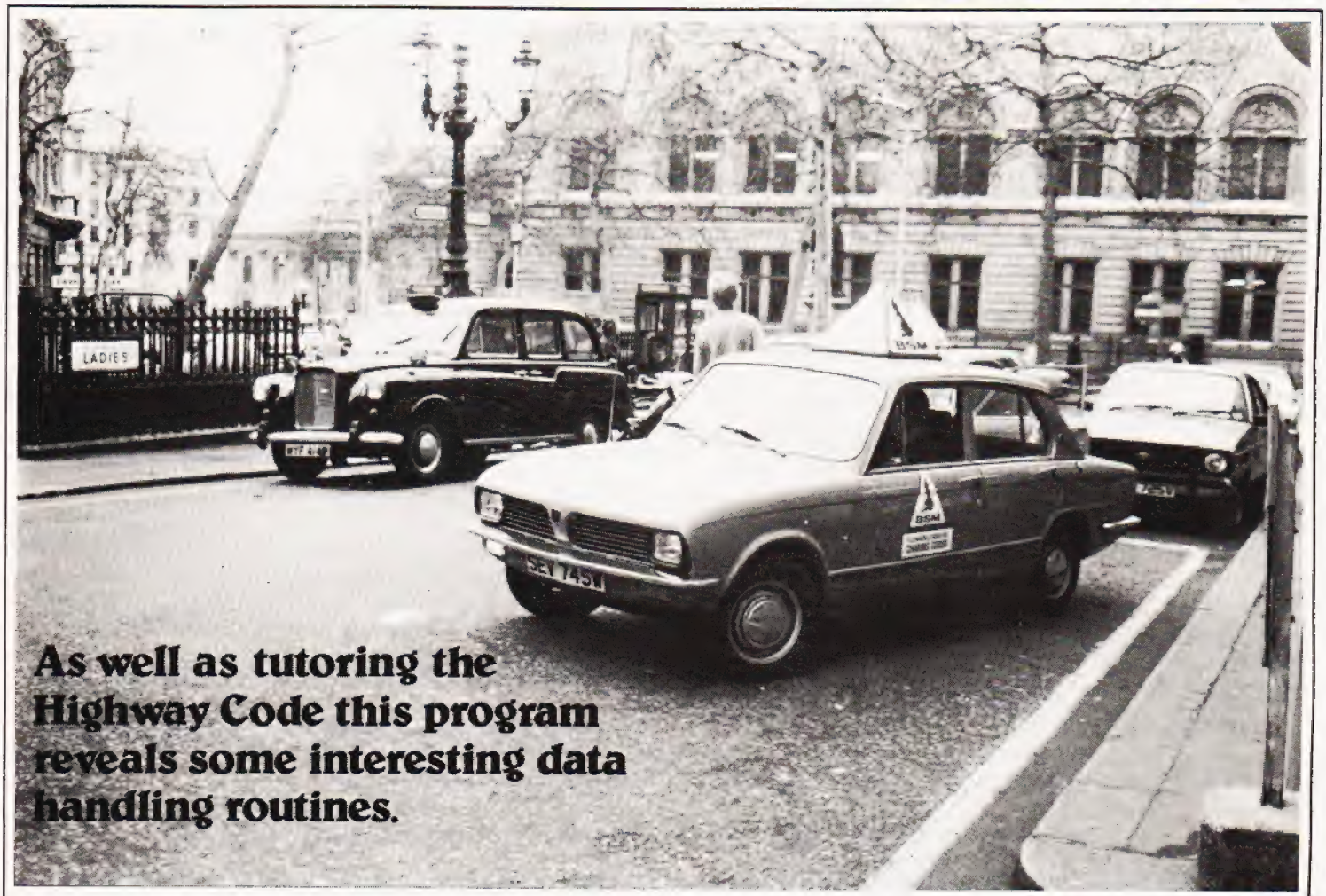
DRIVING TEST

Rex Tingey



As well as tutoring the Highway Code this program reveals some interesting data handling routines.

A candidate for the driving test who is attending a driving school can learn to drive in a simulated steering and controls set-up, followed by tuition in a dual-controlled car, with, perhaps, a classroom lesson on road signs and their meaning, together with advice on studying the Highway Code. The microcomputer can be used to good effect in assisting in *this* study, in particular by the type of program discussed here. The program shown is designed to help the learner-driver by providing stimulating questions based on many aspects of the Highway Code, giving both tuition and revision, together with a means of assessing any areas where the learner's knowledge may be weak or inadequate.

This article also highlights features in the construction of data banking, where coded data of a complex nature can be retrieved as a single unit, but used for multiple purposes.

One Question — Four Answers

The program presents a type of multiple choice question test. A set of questions, each of which has four possible answers is given, some or all of which could be correct. The answer to each question are labelled A, B, C and D. The learner has to respond by pressing the corresponding keys, followed by 'N' (for NO more answers) if all the correct responses have been entered on the keyboard.

Every correct series of reponses for a question earns five points, and every incorrect response loses two points. However, the scoring is not really important, the significant action of the program is to print out all errors so that areas of knowledge requiring revision can be noted with ease. The method adopted is to print out any question to which a wrong answer has been selected, whenever the wrong response has been entered. At the end of the test the printer will have printed out lines of questions, each of which represents an incorrect response. This provides the driving instructor, or whoever, with information on areas of weakness, and advice or revision can be given accordingly.

So that the printer may print out the incorrectly answered question without confusion, all the question and answer sets are in upper case. To make the program visually more interesting, upper and lower case could be used, but it should be noted that the first questions contain graphics, so that a line reading: IF A<4 THEN POKE 59468,12 would need to be incorporated before the line printing to screen. Otherwise a character data filter, based on the ASCII code, could be used to convert all lower case data to upper case for the purpose of error printout; this would take the program outside its present 8K, when run.

The Program

To enable each of the 40 question and answer sets to appear only once during the test, but in a random sequence, the numbers, 01 to 40 are shuffled using the standard card shuffle. The "cards", in this case, must be pairs of numbers, so that pick-up is correct: a "pack" of numbers up to 99 can be shuffled in this way. The new order of random sequence becomes the string D$, and the numbers from this string are extracted, as required, as subroutine 7000 as A, pair by pair. A is used when reading the restored data until that numbered position of data is encountered, whereupon the question is extracted as string A$, and the answer set as string B$.

The string A$ has, at its right-hand end, a four figure code

for the correct answers; this is '1111' if all the answers are correct, and '0100' if only answer B is correct, to give two examples. The string B$ set of answers, all in one, are broken into four equal parts, so unequal answer lengths must be brought to equal length by using spaces or noughts, noughts are used here, together with a number coding the equality. This enables the surplus to be counted and removed before display; for example:

A$ question; "How long is a foot rule?1000"
B$ answer; "=12inch02=25mm1=8inch003=3cm"

obeys the clauses as defined. When A$ and B$ of a question/answer set are extracted from the data, then A$ has its four right-hand characters removed as Y string and the rest is printed to the screen; B$ is broken into four equal strings, O$, P$, Q$ and R$ which have their numerical left-hand ends removed, should there be one, before printing to the screen next to the appropriate characters.

By using multiple data banking, data can be extracted more quickly, information can be grouped together in data and extracted as a whole, and memory space can be used with great economy, particularly with short answers of nearly the same length, since few commas and quotes need be used.

Responses are sensed as a string Z$ and these are checked to see first if the response is 'N' and then if in the range of 'A' to 'D'. Responses greater than this, apart from 'N', are rejected. Responses within the required range are checked against the answer code by a numerical breakdown system, and if the entry corresponds then the program prints that the entry is correct, together with the letter of the key so that repeat entries are not made by mistake. If the entry is incorrect the program prints the letter of the key pressed at the same time as printing out the question to which the incorrect answer has been given on the printer.

Space Saving

The program just fits into 8K, when run, and when the longest string has been formed in memory, which is why there are no instructions at the front end of the program. These could be introduced as a short introductory program setting out the rules of the test.

The delay is for the completion of the card shuffle. Some of the question/answer sets can be revised using the rules as stated; note that in the listing some of the questions with graphics utilize a double line for their presentation. If the 8K is limiting the length of the program then some memory could be saved by deleting the quotes at the front end of data, but they must be left in front of lines using graphics or the graphics will disappear. Some BASICs will require that the quotes are left in, even in totally upper case data.

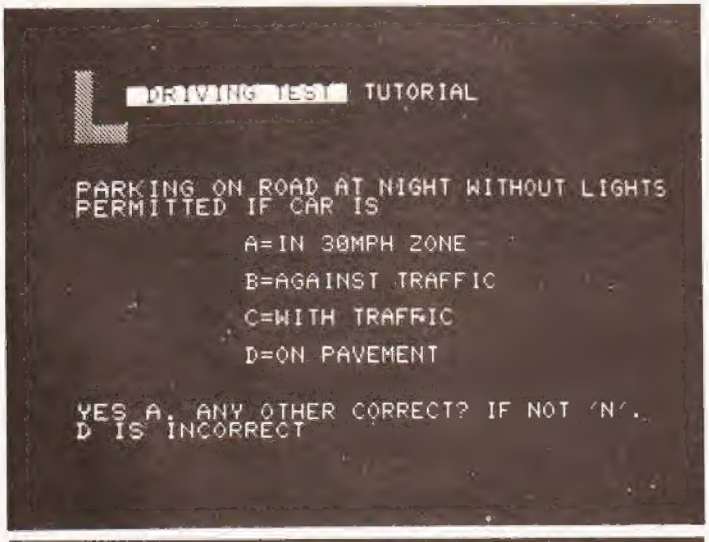
In practical use it is a good idea to have the computer and VDU separate from the printer. Because of the random nature of the test, and the wide coverage of the range of questions, albeit confined to the narrow subject of the Highway Code, the same test could be given again and again without the possibility of remembering the correct responses from an earlier test. So, apart from lucky guesses, the questions may be used with confidence as a test of acquired knowledge over several weeks, remembering, of course, that the object is to assist in the teaching of good driving itself, not merely to pass the inevitable driving test.

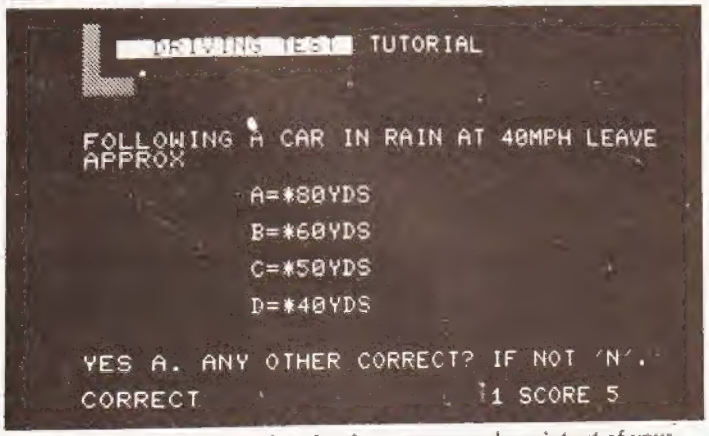
```
 10 Y=1:O=-1:PRINT SPC(8)" [CLS] [4 CD]
    READ INSTRUCTIONS":OPEN 4,4:PRINT#4
120 PRINT#4,CHR$(1)"DRIVING TUTORIAL"
140 PRINT#4,"THESE YOU ANSWERED
    INCORRECTLY— STUDY THE HIGHWAY
    CODE!
200 C$="0102030405060708091011121314151617181
    9202122232425262728293031323334 35
220 C$=C$+"3637383940"
300 R=2*INT(LEN(C$)*RND(1)/2+1)-1:N$=
    MID$(C$,R,2)
330 IF R>1 THEN T$=LEFT$(C$,R-1):GOTO 350
340 T$=" "
350 C$=T$+MID$(C$,R+2):D$=D$+(N$):IF
    LEN(C$)>=1 THEN 300
500 GOSUB 7000:RESTORE:FOR K1=1 TO 40:
    READ A$,B$:IF K1=A GOTO 5000
510 NEXT
700 DATA" ← THIS MOTORWAY SIGNAL
    WITH FLASHING AMBER?1000
702 DATA02LEAVE AT EXIT003CHANGE LANES
    SLIP ROAD AHEAD1DANGER TO LEFT
704 DATA" ▼ IN RED TRIANGLE MEANS
    14'0010
706 DATA00005WIDTH LIMIT0004LENGTH LIMIT
    0004HEIGHT LIMIT DISTANCE TO ROAD
708 DATA" \ TRAFFIC MERGE SIGN WILL BE
    INSIDE ^0010
710 DATA"00005RED HECTAGON0000007RED
    CIRCLE00005RED TRIANGLE INVERTED
    TRIANGLE
720 DATA" ! IN RED TRIANGLE MEANS1001
722 DATA"1DANGER AHEAD02CLEAR AHEAD
    END OF HAZARD02HAZARD NEAR
724 DATA" OAS M-WAY SIGNAL MEANS1000
726 DATA"1RESTRICTION ENDS00005DANGER
    AHEAD000006CROSS-WINDS TEMPORARY
    REPAIRS
728 DATA"QUALIFIED DRIVER DISPLAYING
    L-PLATES HAS SPEED LIMIT OF1000
730 DATA"*45MPHNORMAL*30MPH*60MPH
732 DATA"AT 30MPH,CONDITIONS GOOD,CAR
    CAN STOP IN0001","*30FT*40FT*60FT*75FT
734 DATA"ON M-WAY DRIVE AT SPEED IN0001
736 DATA"02FAST LANE ONLY MIDDLE LANE
    ONLY003MIDDLE & FAST SLOW,MIDDLE &
    FAST
738 DATA"CROSS DOUBLE SOLID WHITE LINES
    IN ROAD ONLY TO0110
740 DATA"PASS SLOW TRACTOR1PASS
    STOPPED CAR0000007TURN RIGHT0004PARK
    ON RIGHT
742 DATA"IN ONE WAY STREET OVERTAKE
    SAFELY IN1111
744 DATA"02LEFT LANE MIDDLE LANE003ANY
    LANE1RIGHT LANE
746 DATA"ENTER ROUNDABOUT TO LEAVE AT
    1ST EXIT1010
748 DATA"1ON INSIDE LANE ON OUTSIDE LANE1
    REMAIN ON LEFT REMAIN TO RIGHT
750 DATA"PARKING INTO DRIVE OF HOUSE ON
    MAIN ROAD0100
```

```
752 DATA"0004ENTER QUICKLY REVERSE THRO GATE02ENTER FRONT 1ST1USE HAND SIGNALS
754 DATA"CAR EMERGING FROM PETROL STATION: RIGHT OF WAY WITH0101
756 DATA"003EMERGING CAR1THE PEDESTRIAN 02CARS ENTERING CARS FROM RIGHT
758 DATA"DAYTIME VISIBILITY REDUCED BY HEAVY RAIN USE0100
760 DATA"SIDE LIGHTS ONLY DIPPED HEADLAMPS0000007FOG-LAMPS0000007FULL BEAM
762 DATA"HEADLIGHTS NEED NOT BE USED AT NIGHT1000
764 DATA"IN LIT STREETS1ON LIT M-WAYS0000007AT DAWN0000007AT DUSK
766 DATA"HORNS SHOULD NOT BE USED IN TOWN1010
763 DATA"003BEFORE 7AM0004AFTER 8PM AFTER 11.30PM0004AFTER 7PM
770 DATA"YOU CANNOT PARK1111
772 DATA"0004AT BUS-STOP000006ON A BEND AT FIRE HYDRANT ON THE FOOTPATH
774 DATA"USE HAZARD WARNING FLASHES WHEN CAR IS MOVING ONLY0001
776 DATA"00000008IN FOG IN EMERGENCIES CARRYING LOADS000000009NEVER
778 DATA"PARKING ON ROAD AT NIGHT WITHOUT LIGHTS PERMITTED IF CAR IS1010
780 DATA"02IN 30MPH ZONE AGAINST TRAFFIC003WITH TRAFFIC0004ON PAVEMENT
782 DATA"ON M-WAY STUDS MARKING LEFTHAND EDGE ARE0001", "GREEN WHITE AMBER02RED
784 DATA"IF SLOW-MOVING VEHICLE OBSTRUCTS CENTRAL M-WAY LANE0100
786 DATA"1OVERTAKE ON LEFT OVERTAKE ON RIGHT0000007SOUND HORN00005FLASH LIGHTS
788 DATA"RED FLASHING M-WAY SIGNALS MEAN0010
790 DATA"GO WITH CAUTION003HAZARD AHEAD00000000011STOP000006SLOW DOWN
792 DATA"ON AUTO-BARRIER LEVEL CROSSING-BELL & LIGHTS START: THEN0001
794 DATA"REVERSE BACK STOP & PHONE1CHANGE LANES02KEEP GOING
796 DATA"ON ROAD BOUNDING AIRFIELD ALTERNATING RED LIGHTS FLASH:THEN0101
798 DATA"02GO WITH CAUTION0000000000013 STOP WAIT FOR AIRCRAFT0004WAIT FOR 'GO'
800 DATA"TURNING LEFT SIGNAL MEANS0111
802 DATA"003PLEASE PASS MOVING-IN LEFT02TURNING LEFT000006STOPPING
804 DATA"3 YELLOW LINES ON CURB: LOADING:0001
806 DATA"00005RESTRICTED ONLY AT WEEKEND1ONLY ON SUNDAY0004NONE AT ALL
808 DATA"SIGN GIVING LOCAL DIRECTIONS HAS0010
810 DATA"0000007NO BORDER0004BLACK BORDER00005BLUE BORDER GREEN BACKGROUND
812 DATA"CYCLE ON ROAD MUST HAVE1100
814 DATA"0004HORN OR BELL EFFECTIVE BRAKES0000000010A PUMP0000000010LIGHTS
816 DATA"MAX.SPEED ON ROADS NOT M-WAYS OR DUAL C'WAYS0100
818 DATA"*70MPH*60MPH*50MPH*45MPH
820 DATA"AT NIGHT CARAVAN MAY PARK WITH NO LIGHTS ON0001
822 DATA"02SIDE ROAD WELL-LIT RD*30MPH ZONE000006NEVER
824 DATA"INJURY IN CAR ACCIDENT:PRODUCE TO POLICE THE0100
826 DATA"000000009LOG BOOK CERT.OF INSURANCE02DRIVING LICENCE REGISTRATION BOOK
828 DATA"WHEN DRIVING TO FAR ROUNDABOUT EXIT0111
830 DATA"1ENTER LEFT LANE ENTER RIGHT LANE LEAVE ON OUTSIDE1LEAVE ON INSIDE
832 DATA"FOLLOWING CAR AT 60MPH LEAVE APPROX0001
834 DATA"*30YDS*40YDS*50YDS*60YDS
836 DATA"FOLLOWING A CAR IN RAIN AT 40MPH LEAVE APPROX1000
838 DATA"*80YDS*60YDS*50YDS*40YDS
840 DATA"APPROACHING CAR DAZZLES WITH HIS LIGHTS—YOU SHOULD 0001
842 DATA"02SOUND HORN FLICK LIGHTS FULL BEAM ON003SLOW DOWN
844 DATA"SHORTEST STOPPING DISTANCE DRIVING FULL SPEED ON M-WAY1000
846 DATA"*105YDS*95YDS*75YDS*65YDS
848 DATA"RED CIRCLE WITH PLAIN WHITE CENTRE MEANS0010
850 DATA"NO RESTRICTIONS0000007CLEARWAY 0004NO VEHICLES0000007GIVE WAY
852 DATA"LEGAL MINIMUM DEPTH OF TYRE TREAD0100
854 DATA"1>.5MM02>1MM>1.5MM02>2MM
856 DATA"WARNING TRIANGLE SHOULD BE PUT AT LEAST ....YDS BEFORE HAZARD0010
858 DATA"*35*40*50*60
860 DATA"WARNING TRIANGLE SHOULD BE PUT AT LEAST...YDS BEFORE M-WAY HAZARD0100
862 DATA"*200*150*1001*60
5000 GOSUB 8000:L=LEN(A$):Y$=RIGHT$(A$,4):A$=LEFT$(A$,L-4):PRINTA$:M=LEN(B$)
5020 M=M/2:M$=RIGHT$(B$,M):N$=LEFT$(B$,M):N=M/2:O$=RIGHT$(M$,N):P$=LEFT$(M$,N)
5030 Q$=RIGHT$(N$,N):R$=LEFT$(N$,N):C=VAL(O$):B=LEN(O$):O$=RIGHT$(O$,B-C)
5040 C=VAL(P$):B=LEN(P$):P$=RIGHT$(P$,B-C):C=VAL(Q$):B=LEN(Q$)
5060 Q$=RIGHT$(Q$,B-C):C=VAL(R$):B=LEN(R$):R$=RIGHT$(R$,B-C)
```

DRIVING TEST

```
5080 PRINT," [CD ]A="R$:PRINT," [CD ]B="Q$:
     PRINT," [CD ]C="P$:PRINT," [CD ]D="O$
     " [2 CD ]":Y=VAL(Y$)
5090 X=Y:IF Y>999 THEN A=1:Y=Y-1000
5100 IF Y>99 THEN B=1:Y=Y-100
5110 IF Y>9 THEN C=1:Y=Y-10
5120 IF Y=1 THEN D=1
5200 GET Z$:IF Z$=" " GOTO 5200
5202 IF Z$="N" GOTO 5900
5208 IF Z$>"D" GOTO 5200
5210 IF Z$="A" GOTO 5400
5220 IF Z$="B" GOTO 5500
5230 IF Z$="C" GOTO 5600
5240 IF Z$="D" GOTO 5700
5400 IF A=1 GOTO 5420
5410 GOSUB 20000:.GOSUB 30000:GOTO 5200
5420 X=X-1000:A=0:GOTO 5800
5500 IF B=1 GOTO 5520
5510 GOSUB 20000:GOSUB 30000:GOTO 5200
5520 X=X-100:B=0:GOTO 5800
5600 IF C=1 GOTO 5620
5610 GOSUB 20000:GOSUB 30000: GOTO 5200
5620 X=X-10:C=0:GOTO 5800
5700 IF D=1 GOTO 5720
5710 GOSUB 20000:GOSUB 30000:GOTO 5200
5720 X=X-1:D=0:GOTO 5800
5800 PRINT"YES "Z$". ANY OTHER CORRECT? IF
     NOT 'N'."
5810 GET Z$:IF Z$=" " GOTO 5810
5820 IF Z$="N" GOTO 5900
5830 IF Z$<"E" GOTO 5210
5840 IF Z$>"D" GOTO 5810
5900 IF X>0 THEN GOSUB 20000
5910 IF X=0 THEN GOTO 6000
5920 GOSUB 30000:GOTO 5200
 6000 I=I+5:J=J+1:PRINT" [CD ]CORRECT"SPC
     (18)J"SCORE"I:K4=0:TI$="000000"
 6015 IF TI$<"000005" GOTO 6015
 6020 GOTO 500
 7000 O=O+2:O$=MID$(D$,O,2):A=VAL(O$):IF
     O>80 GOTO 9000
 7010 RETURN
 8000 PRINT" [CLS ]":PRINT"DRIVING TEST
     TUTORIAL":RETURN
 9000 GOSUB 8000:PRINT" [CD ]SCORE"I" OUT OF
     200":CLOSE 4:END
20000 IF L>45 THEN PRINT #4,A$
20002 IF L>44 GOTO 20010
20004 RETURN
20010 B$=LEFT$(A$,40):M$=RIGHT$(A$,L-44):
     PRINT #4,B$:PRINT #4,M$:RETURN
30000 PRINT Z$"IS INCORRECT":I=I-2: RETURN
```






```
DRIVING TUTORIAL
These you answered incorrectly-
study the Highway Code!

USE HAZARD WARNING FLASHERS WHEN CAR IS
MOVING ONLY

DAYTIME VISIBILITY REDUCED BY HEAVY RAIN
USE

AT NIGHT CARAVAN MAY PARK WITH NO LIGHTS
ON

IF SLOW-MOVING VEHICLE OBSTRUCTS CENTRAL
TRAFFIC LANE
```

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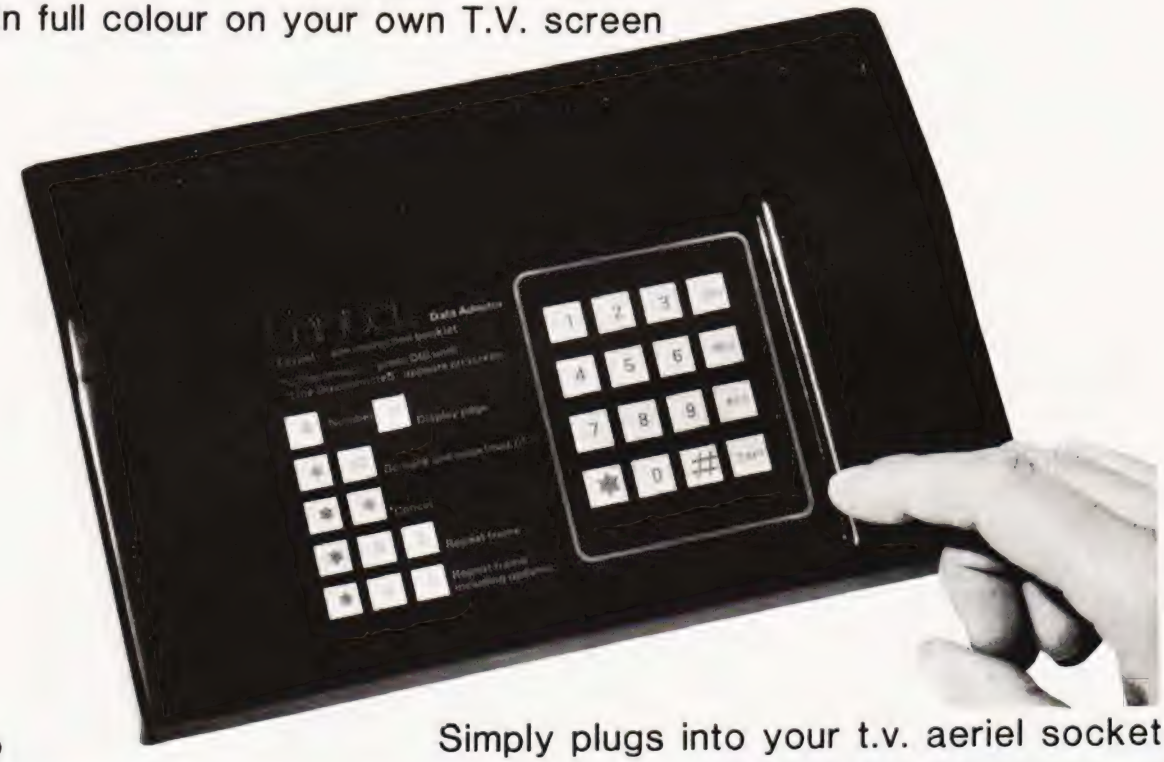

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A. Daviel

Whilst bubbles drift along the shellsort really speeds up the flow of data.

If you run ALPHASORT as published in September CT, you will notice that though it is very fast indeed for short lists, it takes disproportionately longer for large lists. To be exact, the time taken is proportional to N^2 for a random list of N records.

The following program, though somewhat more complex, takes a time proportional to $N\log_2(N)$. To give an idea of what this means, suppose it is necessary to sort a government census file of one million records. If, on a given machine, the Bubblesort and Shellsort each take 20 milliseconds to sort 64 records, the Shellsort would take half an hour to sort the census file. The Bubblesort — four months! On a more down-to-earth application the Shellsort will sort 250 records in one-fifth of the time.

How It Works

The general principle is that of merging two sorted sequential files — the method by which files are sorted which will themselves not fit into main store. The next record in the merged file is selected from the input file with the record next in order, see Fig. 1. To apply this technique to an array of strings, the array is first split into N lists of one string each. These are merged in pairs to give N/2 lists of two strings, and so on until the whole array has been sorted, see Fig. 2. You will note N has to be a power of two, so that in the example program the array is preset to an artificially high value.

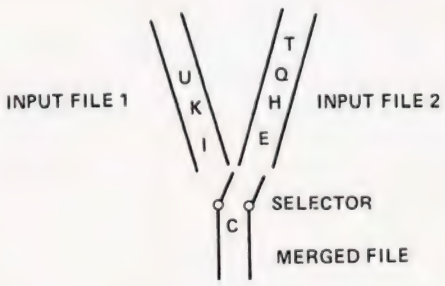

Fig.1. Using selection to merge files

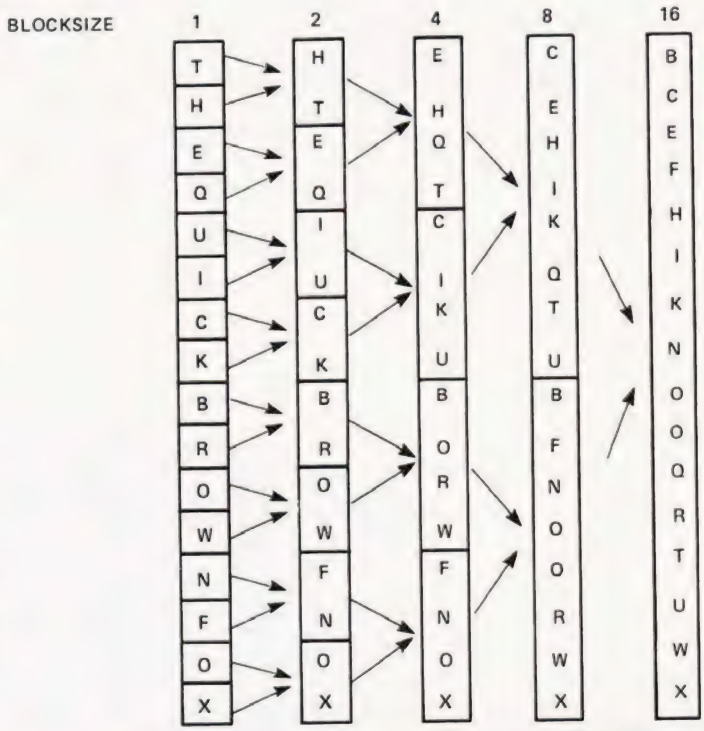

Fig.2. How the files are sorted and merged

Using The Shellsort

The example program, written in Microsoft BASIC, illustrates how the routine is driven. You will observe that the routine does not actually sort the array, but instead returns the array SP as a pointer into the string array. This may sound unduly complicated at first, but by using this method it is not necessary to move the records around (which may be quite long), more than once. In the example program, the records being sorted consist of a single string, but in general they will consist of mixed string and numeric fields. The list will be sorted according to one of these fields, called the key. A$ in line 8250 of SHELLSORT would be replaced by this field.

```
100 PRINT" [CLS ] STRINGSORT"
110 REM INITIALISATION
130 DIM A$(255) : EN = 255 : CT = 0
132 REM PRESET A$ TO MAXIMUM
135 I = 0 TO 255 : A$(I) = CHR$(255) : NEXT
140 PRINT"PLEASE INPUT NAMES,WHEN YOU
    ARE"
150 PRINT"READY TO SORT TYPE'*'"
160 PRINT
170 REM INPUT ROUTINE
180 PRINT"YOU HAVE ROOM FOR ";EN;"MORE EN-
    TRIES"
190 INPUT A$(CT)
200 IF A$(CT) = "*" THEN 250
210 CT = CT + 1 : PRINT" [CLS ]"
220 IF CT > 254 THEN 250
230 EN = 255 - CT : GOTO 180
240 END
245 REM SET NUMBER OF ELEMENTS & CALL
    SHELLSORT
250 SN = CT - 1 : GOSUB 8100
470 REM LINE LOOP OUTPUT
475 FOR KK = 0 TO 9:GET K$:NEXT
```

SHELLSORT

```
480 PRINT"HIT A KEY FOR LIST"
490 GET K$ : IF K$=" " GOTO 490
510 LP=0 : SL=18
520 FOR P= LP TO LP+SL
525 IF P>CT THEN END
527 REM ARRAY SP GIVES POINTER INTO A$
530 PRINT A$(SP(P))
540 NEXT P
545 FOR KK=0 TO 9:GET K$:NEXT
547 PRINT
550 PRINT" **HIT ANY KEY TO CONTINUE**"
560 PRINT" **'$' WILL BREAK**"
565 PRINT
570 GET K$ : IF K$=" " THEN 570
580 IF K$= "$" THEN END
590 LP=LP+SL+1
600 GOTO 520
8000 REM SHELLSORT ROUTINE
8010 REM THIS ROUTINE WILL SORT A
8020 REM STRING ARRAY A$
8030 REM INTO ASCENDING ORDER.
8035 REM THE ROUTINE RETURNS SP(SN-1)
8040 REM AS A POINTER ARRAY INTO THE
8045 REM LIST. THE ROUTINE USES
8050 REM VARIABLES PREFIXED 'S'.
8070 REM THE ROUTINE TAKES ABOUT 2 MIN.
8075 REM TO SORT A 256 ELEMENT LIST
8080 REM THE TIME TAKEN IS PROPORTIONAL
8085 REM TO 2*LOG2(N)*N.
8100 SS=(INT(LOG(SN)/LOG(2))+1)
8110 SN= 2↑SS:REM SN MUST BE A POWER OF 2
8140 REM SS IS NO OF STEPS
8150 DIM SP(SN) : DIM SQ(SN)
8160 FOR SI= 0 TO SN-1
8170 SP(SI)= SI : NEXT SI
8180 SB= 1 : SP= 1:REM BLOCKSIZE,STEP NO
8190 IF S>SS THEN RETURN
8195 PRINT" [CLS ]SORTING: BLOCKSIZE=";SB
8200 SJ= SN/2:SI= 0:SK= 0
8210 SL= SB+SI : SM= SB+SJ
8220 IF(SJ>=SM)AND(SI>=SL) GOTO 8300
8230 IF(SJ>=SM) GOTO 8260
8240 IF(SI>=SL) GOTO 8280
8250 IF A$(SP(SI))>A$(SP(SJ)) GOTO 8280
8260 SQ(SK)=SP(SI)
8270 SK= SK+1 : SI= SI+1 : GOTO 8220
8280 SQ(SK)= SP(SJ)
8290 SK=SK+1 : SJ= SJ+1 : GOTO 8220
8300 IF SK>SN-1 GOTO 8320
8310 SM= SM+SB : SL= SL+SB: GOTO 8220
8320 FOR SI= 0 TO SN-1
8330 SP(SI)=SQ(SI): NEXT
8340 SB= SB*2 : SP=SP+1
8350 GOTO 8190
```

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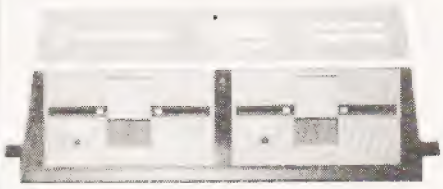

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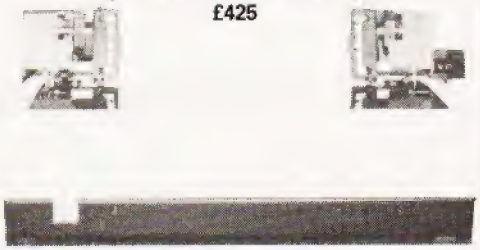

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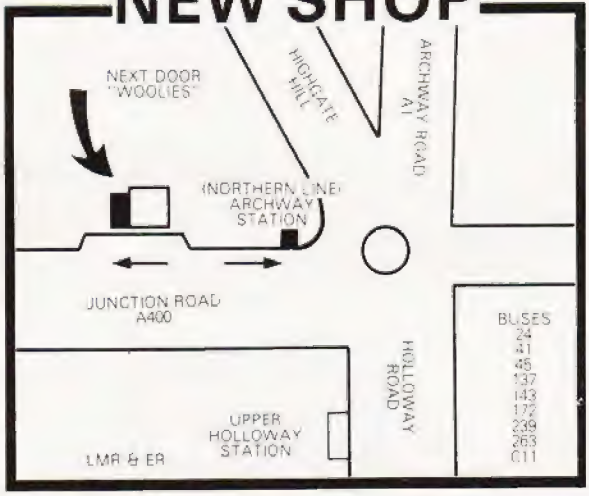

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This program is designed to run on a Level II TRS80 equipped with a printer and it occupies under 4K bytes. It accepts a list of words and then constructs a word puzzle of the type you have, no doubt, seen for sale in newsagents.

I find this program very useful, the puzzles it produces keep my family occupied for hours on end while I am at the keyboard! It is designed to be used by "non-computer" people, this is the reason for the emphasis on input error trapping and the "chatty" style of the prompts.

Many of the statements are special features of the TRS80, notably CLS, which clears the screen, and INKEY$, which is a single keyboard scan and does not need the 'ENTER'. I believe the PET has a similar statement called 'GET'. Only one PEEK is used and this is not essential to program operation anyway, which should please some readers.

How It Works

The wordsquare and the list of words to be used are represented by string arrays S$(n,m) and W$(n) respectively, the program attempts to find vacant areas or matching letters in the array S$(n,m) and put in the words from W$(n). It will try all directions, including backwards and diagonally and a fair amount of string handling takes place. Not suprisingly, the program can take several minutes to run, in fact it will sometimes appear to 'hang and won't even respond to the break key. This is due to the fact that the TRS80 has to reorganise its string storage areas occasionally and ignores the keyboard while it is doing this. (This is called Garbage Collection and was discussed in last month's issue.)

When the puzzle has been constructed it will first be displayed on the screen without the usual jumble of random letters, you can cheat at this point if you wish. The video display section is included for debugging and checking purposes, if you wish to remove it then delete lines 730-800. There is an option for suppressing the usual list of words which are included in the puzzle, this makes it much more difficult, the only clues given in this case are a list of dashes corresponding to word lengths, I have included an example of each option. I am sure readers will find them trivial!

The wordlist W$(n) is sorted into words of descending length because this reduces excecution time by allowing the longest words to be put into a nearly vacant array first, the shorter words are then fitted around and through them.

The randomising methods used ensure that no two puzzles are similar even though they may contain the same words.

Variables Used

A,C,D,G,P,X,I	Counters temporary storage integers.
C(n)	List of shuffled vertical coordinates.
C1,C2	Temporary storage for vertical coordinates.
D(n)	List of shuffled directions.

SALTY

```
F P U Y Y Y O K R V B Z F L L  PERIWINKLE
V P E R I W I N K L E E Y X N  SEASHELL
X E R U M E Q S L E S S U M C  STARFISH
Z C L A M W H S I F R A T S N  SCALLOPS
N S B S L O N E S L I M P E R  ABALONES
K L E H W C S O B R O Z A R U  COCKLES
E U C H I D C E C O Y S T E R  COWRIES
P C O N C H A A A O L Y L J O  MUSSELS
K T W R H I L F T S C R Z E Y  OYSTER
T R R T Q P L S S J H K A X E  LIMPET
N D I J F K O T X Y X E L E B  RAZOR
V N E H I M P K R X S X L E P  CONCH
S H S C Z N S B Z G S N G L S  WHELK
M S F P S O X C Q L T U A G U  PEARL
W P L M S C B S K L J Y T O Z  MUREX
                              CLAM
```

BYTE THIS

```
Z C L O A D Y X L N U W Y N C  ..............
Q T U Y A H D U O A D D G O B  ..........
F I T A R F E X W O N W W I E  ..........
E E W S T A R P M A I G K T N  ..........
Y J E N S W N E T Z F B M U C  ..........
Y A D O T G N I T U P M O C H  ..........
T I N T E G E R B N R Q T E M  ..........
M S O F T W A R E T I X W X A  ........
I I N T E R R U P T Z R B E R  ........
G M I C R O S O F T P P P W K  .......
B H E X A D E C I M A L F K S  .......
H B L R E N I T U O R B U S D  ......
M H T I R O G L A Q U U R Q X  .....
B C K R Y O L S G U B E D Z P  .....
C P J Q D D R L E D J K K E W  .....
                             ----
```

Two specimen "Wordsquares" as produced by the program

WORDSQUARE

Q$	Temporary storage for single letter replies.
R(n)	List of shuffled horizontal coordinates.
R,R1,R2	Temporary horizontal coordinates.
S$	Temporary storage inputted words.
S$(n,m)	The string array representing the wordsquare.
T$	Title.
W$(n)	List of inputted words.
W1,W2	Pointers into W$(n),
X1,X2	Used in row and column shuffle.

Program Listing

```
10    REM WORDSQUARES
20    REM
30    REM INITIALISE
40    CLS
50    CLEAR 400
60    DEF INT A-Z
70    DIM C(15),R(15),D(8),W$(16),S$(15,15),R2(15),C2(15)
80    PRINT TAB(20)"WORDSQUARES"
90    PRINT TAB(20)"_____"
      YOU WILL NEED A PRINTER FOR THIS PROGRAM. TYPE IN A LIST OF UP TO 16 WORDS OR TYPE '@' IF YOU WISH TO USE LESS. THE MAXIMUM NUMBER OF LETTERS IN A WORD IS 15, BUT IF YOU"
100   PRINT"USE TOO MANY LONG WORDS THE PROGRAM WILL TAKE AGES TO RUN. IN FACT IT MAY NOT BE ABLE TO FIT YOUR WORDS IN AT ALL! IF SO IT WILL TELL YOU (EVENTUALLY)"
100   REM**SHUFFLE COORDINATES
120   FOR A=1 TO 15:C(A)=A:R(A)=A:IF A<9 THEN D(A)=A
130   NEXT
140   FOR A=1 TO 15
150   R1=RND(15):R2=RND(15):X1=R(R1):X2=C(R2):R(R1)=R(A)
      C(R2)=C(A):R(A)=X1:C(A)=X2
160   NEXT
170   REM**INPUT WORDLIST
180   PRINT"NOW TYPE IN YOUR LIST"
190   FOR W=1 TO 16
200   INPUT S$:IF S$="@" THEN 280
210   IF W=1 THEN CLS:PRINT@2,S$
220   W$(W)=S$
230   REM**TEST THE WORD FOR LENGTH AND CONTENT, S IS ERROR FLAG
240   S=0
250   GOSUB 1030
260   IF S=1 THEN 200
270   NEXT
280   W=W-1
290   CLS:PRINT@590,"THIS COULD TAKE ME A FEW MINUTES";
300   REM**SORT WORDS, LONGEST FIRST
310   GOSUB 1190
320   PRINT@590,CHR$(30);
330   REM**CHOOSE THE NEXT WORD
340   FOR W1=1 TO W
350   REM**RANDOMISE DIRECTIONS
360   FOR A=1 TO 8:R=RND(8):X=D(R):D(R)=D(A):D(A)=X:NEXT
370   REM**CHOOSE A COORDINATE
380   FOR R=1 TO 15
390   PRINT@600,"THINKING";
400   FOR C=1 TO 15
410   R1=R(R):C1=C(C)
420   REM**CHOOSE A DIRECTION
430   FOR D=1 TO 8
440   REM**CAN IT BE FITTED?
450   FOR I=1 TO LEN(W$(W1))
460   ON D(D) GOSUB 1090,1100,1110,1120,1140,1150,1160,1170
470   REM**OFF THE EDGE?
480   IF R2>15 OR R2<1 OR C2>12 OR C2<1 THEN 580
490   S$=MID$(W$(S1),I,1)
500   IF S$(R2,C2)<>""AND S$(R2,C2)<>S$ THEN 580
510   R1=R2:C1=C2:R2(I)=R2:C2(I)=C2
520   NEXT I
530   REM**OK WE HAVE A WORDFIT SO PUT IT IN THE ARRAY
540   FOR I=1 TO LEN(W$(W1))
550   S$(R2(I),C+(I))=MID$(W$(W1),I,1)
560   NEXT I
570   GOTO 700
580   NEXT D
590   REM**MUST HAVE FAILED TO FIND FIT SO TRY ELSWHERE
600   PRINT@609,"HARD!"
610   NEXT C
620   PRINT@600,CHR$(30);
630   NEXT R
640   REM**TO GET HERE MUST HAVE FAILED FOR ENTIRE ARRAY
650   CLS:PRINT"SORRY, I CANT COPE WITH ";W$(W1);". DO YOU WANT TO START"
660   PRINT"AGAIN (PRESS 'S') OR PRINT OUT THE PARTLY DONE WORDSQUARE ANYWAY (PRESS 'P')"
670   Q$=INKEY$:IF Q$="" "THEN 670
680   IF Q$="S" THEN RUN ELSE CLS GOTO 730
690   REM**GET THE NEXT WORD
700   NEXT W1
710   REM**PRINT OUT THE ARRAY TO SCREEN
720   PRINT@600,"GOT IT!!!";CHR$(30);:FOR A=1 TO 800:NEXT CLS
730   FOR R=1 TO 15
740   PRINT
750   FOR C=1 TO 15
760   IF S$(R,C)=" "THEN PRINT" ";:GOTO 780
770   PRINT S$(R,C);" ";
780   NEXT C,R
790   PRINT"PRESS A KEY",
800   IF INKEY$="" "THEN 800
810   CLS
820   REM**PRINTER STATUS CHECK (OPTIONAL)
830   GOSUB 1260
840   REM**PRINT TO PRINTER
850   PRINT"TYPE IN A TITLE FOR YOUR WORDSQUARE THEN PRESS ENTER"
860   PRINT
870   INPUT T$
880   PRINT"BY THE WAY, DO YOU WANT THE WORDLIST PRINTED AS WELL? (Y OR N)"
890   Q$=INKEY$:IF Q$="" "THEN 890
900   IF Q$<>"Y" AND Q$<>"N" THEN 890
910   LPRINT TAB(25)T$
920   LPRINT TAB(25)STRING$(LEN(T$),"-"):LPRINT
930   FOR R=1 TO 15
940   FOR C=1 TO 15
950   IF S$(R,C)=" " THEN LPRINT CHR$(RND(26)+64);" ";ELSE LPRINT S$(R,C);" ";
960   NEXT C
970   IF Q$="N" THEN LPRINT TAB(48)STRING$(LEN(W$(R)),"-")ELSE LPRINT TAB(48)W$(R)
980   LPRINT
990   NEXT R
1000  IF Q$="N" THEN LPRINT TAB(48)STRING$(LEN(W$(R)),"-")ELSE LPRINT TAB(48)W$(R)
1010  FOR X=1 TO 4:LPRINT:NEXT:RUN
1020  REM**INPUT TESTING
1030  IF LEN(W$(W))>15 THEN S=1:PRINT"THIS WORD IS TOO LONG, TRY AGAIN":RETURN
1040  FO A=1 TO LEN(W$(W))
1050  S$=MID$(W$(W),A,1)
1060  IF S$<"A" OR S$>"Z" THEN S=1:PRINT"LETTERS ONLY PLEASE.":RETURN
1070  RETURN
1080  REM**HORIZONTALS AND VERTICALS
1090  R2=R1+1:RETURN
1100  R2=R1-1:RETURN
1110  C2=C1+1:RETURN
1120  C2=C1-1:RETURN
1130  REM**NOW THE DIAGONALS
1140  R2=R1+1:C2=C1+1:RETURN
1150  R2=R1+1:C2=C1-1:RETURN
1160  R2=R1-1:C2=C2+1:RETURN
1170  R2=R1-1:C2=C2-1:RETURN
1180  REM**WORDLENGTH SORT
1190  S=0
1200  FOR W1=1 TO W-1
1210  IF LEN(W$(W1))<LEN(W$(W1+1))THEN S$=W$(W1):W$(W1)=W$(W1+1):W$(W1+1)=S$:S=1
1220  NEXT
1230  IF S=1 THEN 1190
1240  RETURN
1250  REM**PRINTER CHECK TO PREVENT SYSTEM HANG
1260  IF PEEK(14312)<=127 THEN RETURN
1270  PRINT"PRINTER NOT READY!! PRESS 'P' WHEN THE PRINTER IS READY OR 'S' TO START AGAIN"
1280  Q$=INKEY$:IF Q$="" "THEN 1280
1290  IF Q$="S" THEN RUN
1300  IF PEEK(14312)<=127 THEN 1270
1310  IF Q$="P" THEN CLS:RETURN
1320  GOTO 1280
```

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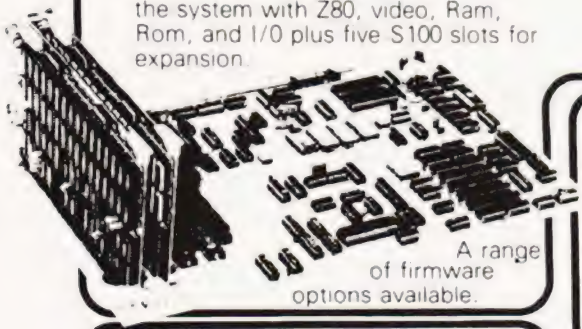

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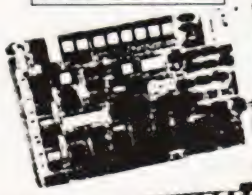

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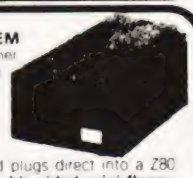

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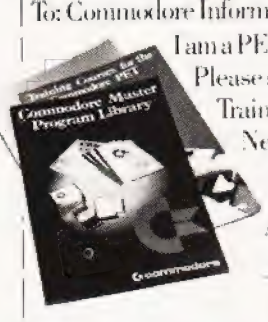

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JOYSTICK CONTROLS

R.A.E. Milton

Make your games go faster with these easy to build controls.

Almost all games that are played on a home computer will benefit from joystick controls, as opposed to using a keyboard. This applies especially to fast moving games, or games that require part of a display to be moved over the entire screen in any direction, with the minimum of effort.

In this project I have attempted to combine a simple, but very effective circuit with a versatile subroutine that can be used with your own game programs. Although initially designed for use with a NASCOM1 with T4, the circuit will work with any Z80 based system which has PIO ports, obviously some software modification will be necessary.

Construction

Building the joysticks should present no problems, even to the inexperienced, as all the information needed for construction is contained within the accompanying diagrams. Once built each joystick should be connected to a PIO port "A" and the test program run. Each pot should give a reading of about 01-28 over the length of travel of the lever in both a horizontal and vertical direction, as shown in Fig. 3. If the reading is too far out, additional capacitors of 1-11 nF can be soldered in parallel with C2. Whilst the actual numbers obtained are not really important, they must be similar in each direction. If making two controls each unit must give similar readings. If you value your PIO remember to disconnect the joystick from the port before applying your soldering iron! The joystick centre position is assumed to be between 9 & 18, this is controlled entirely by software and can be altered in the joystick subroutine to make the central area larger or smaller.

How It Works

The system is started by a negative going pulse, sent by joystick routine via the PIO port to pin 2 of IC1, this causes pin 3 to go high and C2 to start charging via R3 and the joystick pot. Meanwhile the subroutine is checking pin 3 for a low condition, until this is found it will progress in a loop, incrementing register D on each loop (or register E if checking the horizontal control). When the charge across C2 reaches two thirds of Vcc, IC1 will switch and cause pin 3 to go low, also discharging C2 via pin 7. IC1 then remains in this state until the negative trigger pulse arrives. Once pin 3 goes low the subroutine leaves its

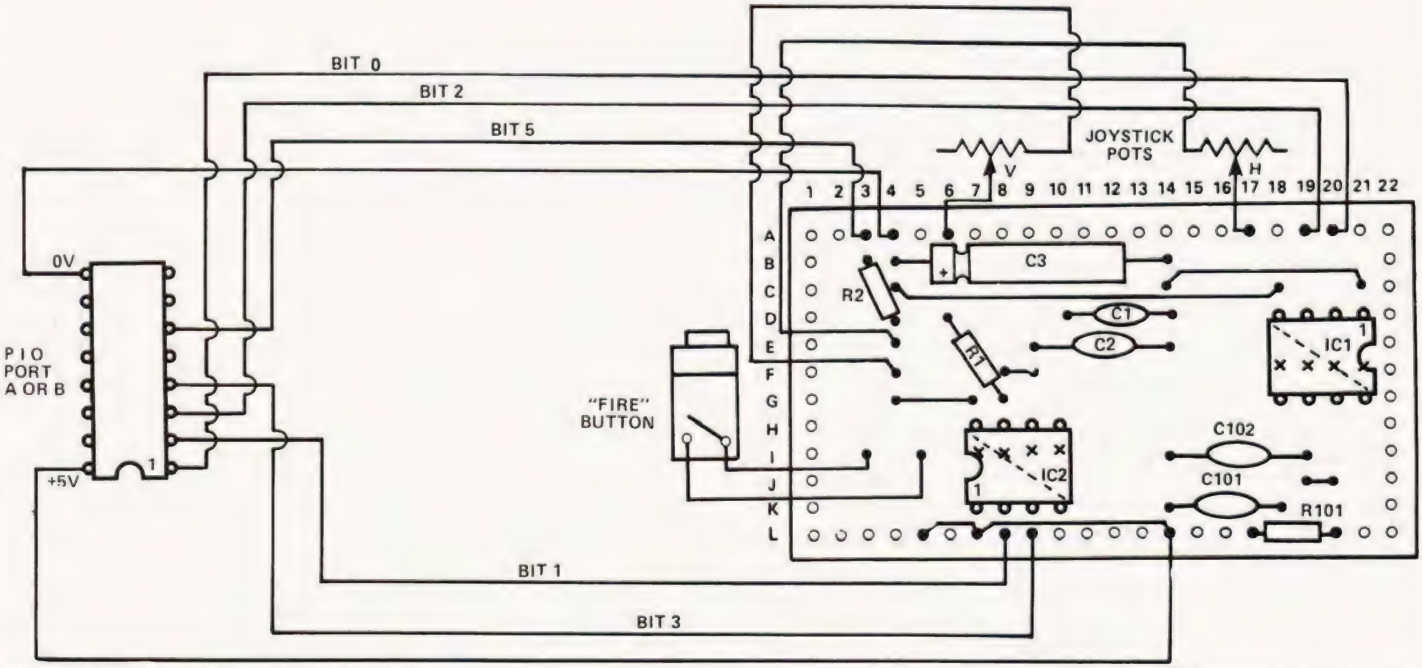

Fig.1. Veroboard layout for the joystick controller.

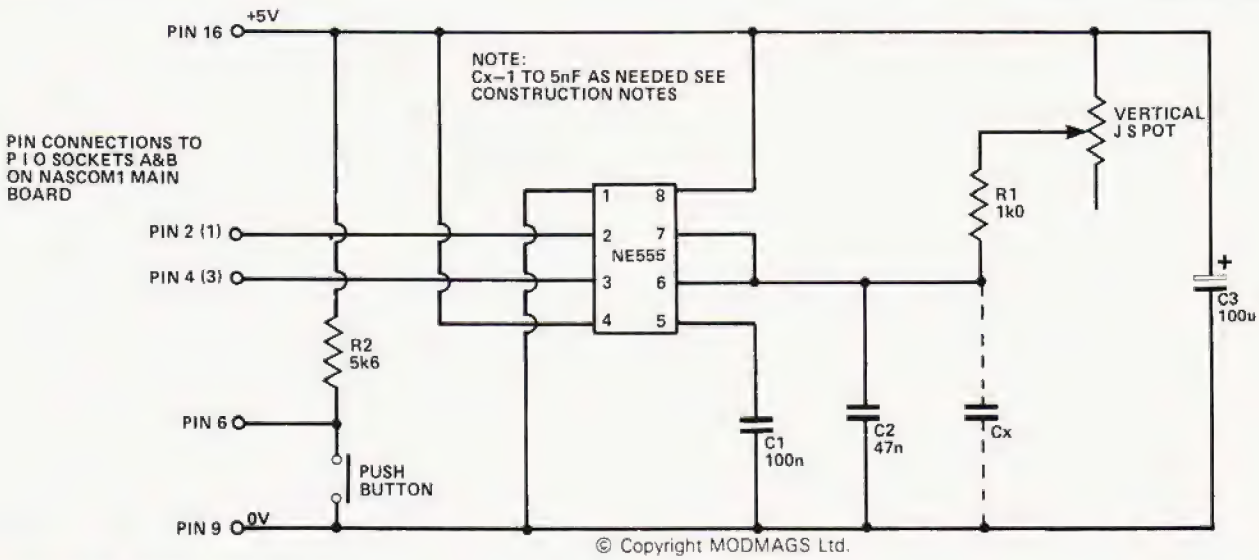

Fig.2. Corresponding circuit diagram.

loop with a value in register D (or E) which is relative to the postion of the joystick. The number of subroutine loops performed is dependent on the charging time of C2, which is in turn controlled by the position of the joystick pot.

R3 holds bit 5 high until the fire button is pressed, this change of condition is sensed by the subroutine which in turn sets the appropriate "fire indicator" to FF.

Joystick Test Routine

This test routine was originally written for use with a NASCOM1. Under control of B-Bug, T2 or T4 monitors. If used with any other system certain changes including relocation in user RAM may be necessary. In an attempt to clarify this, only the lines with comment will need possible alteration.

The test routine as listed assumes that:-

A. Routine is located at, and executed from 0E00.
B. Centre of CRT (TV screen or monitor) is at 099F.
C. PIO port A is addressed as port 6 for control.
D. PIO port A is addressed as port 4 for data.

```
0E00  EF  1E  00          Clear CRT
0E03  21  9F  09          CRT start address
                          in HL
0E06  CD  13  0E          Call "joystick"
0E09  11  22  22
0E0C  1B
0E0D  7A                  Delay
0E0E  B3
0E0F  20  FB
0E11  18  ED
                "Joystick"
0E13  11  00  00
0E16  0E  06              Pointer to port 6
                          (PIO A, control)
0E18  3E  FF
0E1A  ED  79
0E1C  3E  FC
0E1E  ED  79
0E20  3E  03
0E22  0E  04              Pointer to port 4
                          (PIO port A,data)
0E24  ED  79
0E26  AF
0E27  ED  79
0E29  3E  03
0E2B  ED  79
0E2D  ED  78
0E2F  CB  5F
0E31  28  0C
0E33  14
```

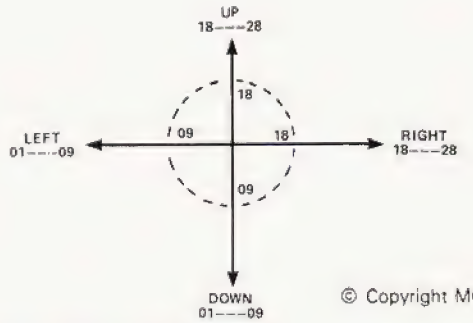

Fig.3. Directions and values produced.

Star Maze

This is a two player game for use on a NASCOM 1 equipped with joystick controls as detailed in the article. Each player controls a spaceship, the object of the game being to reach the central space station before your opponent. This

```
0E34  CB  57
0E36  28  01
0E38  1C
0E39  06  24
0E3B  10  FE
0E3D  18  EE
0E3F  CB  57
0E41  20  F5
0E43  7A
0E44  CD  50  0E           Call "binary to Hex"
0E47  23
0E48  23
0E49  7B
0E4A  CD  50  0E           Call "binary to Hex"
0E4D  C9
              "Binary to Hex"
0E50  F5
0E51  1F  1F  1F  1F
0E55  CD  59  0E           Call "b/H part 2"
0E58  F1
              "B/H part 2"
0E59  E6  0F
0E5B  C6  30
0E5D  FE  3A
0E5F  38  02
0E61  C6  07
0E63  77
0E64  23
0E65  C9
```

JOYSTICK CONTROLS

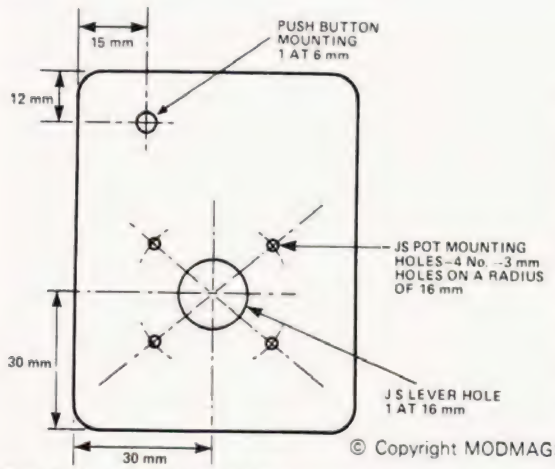

Fig.4. Cutout details for the box.

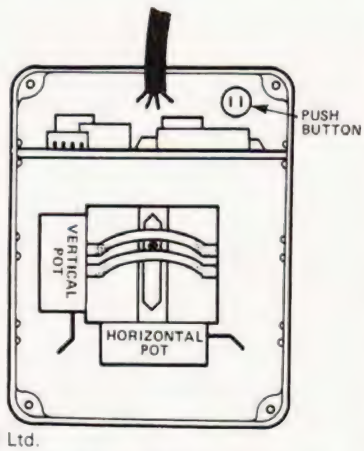

Fig.5. What it looks like from underneath.

PARTS LIST

Resistors, all ¼ W 5%

R1,101	1k0
R2	5k6

Capacitors

C1,101	100 n ceramic
C2,102	47 n ceramic
C3	100 u 16 V electrolytic

Semiconductors

IC1,2	NE555

Miscellaneous
Dual 250k joystick assembly
Push to make switch

must be achieved without colliding with any of the stars which are arranged in a random pattern for each game. By use of the joystick push button each player can 'warp' to a different position of the screen, however this can result in your ship landing on a star with its inevitable destruction. As an added hazard the screen is also littered with invisible black holes (again at random), if your ship happens to hit one of these it will disappear for a few seconds, reappearing at a different place on the screen. Obviously this can result in your ship landing on a star or even in another black hole.

Each player's ship can be moved over the entire screen with use of the joystick controls, moving off the edge of the screen will result in your ship reappearing on the opposite edge. The program contains a subroutine which gives simple sound effects from a sound buffer (see the article in Computing Today, May '79). If you do not wish to use this, simply run the program as listed. The program is loaded from 0C50 to 0FD0 and is executed at 0D3D.

```
                    DATA STORAGE
0C50 00                                 L.H. button indicator
0C51 4C 0B                              L.H. joystick
0C53 00                                 R.H. button indicator
0C54 37 08                              R.H. joystick
0C56 00 00                              Black hole indicators
0C58 70 60 A0 90                        Sound data
0C5C 40 20 50 80                        Sound data

                    INITIALISE
0C60 EF 1E 00       LD A(0C57)          Clear CRT
0C63 AF             XOR A
0C64 06 08          LD B 08             Initialise data store
0C66 21 50 0C       LD HL, 0C50
0C69 77             LD(HL)A
0C6A 23             INC HL
0C6B 10 FC          DJNZ 0C69
0C6D 3E 04          LD A, 04
0C6F 0E 20          LD C, No of stars   Print stars
0C71 16 2E          LD D, Star
0C73 CD D9 0E       Call print random
0C76 3E 04          LD A, 04
0C78 0E 07          LD C, No of holes   Print holes
0C7A 16 A0          LD D,hole
0C7C CD D9 0E       Call print random
0C7F 21 37 08       LD HL, 0837
0C82 22 54 0C       LD(0C54)HL          Initialise ship start positions
0C85 36 20          LD(HL) space
0C87 21 4C 0B       LD HL,0B4C
0C8A 22 51 0C       LD(0C51)HL
0C8D 36 20          LD(HL)20
0C8F 21 A1 09       LD HL, 09A1
0C92 36 9E          LD(HL)9E
0C94 23             INC HL              Print space station
0C95 36 9D          LD(HL)9D
0C97 21 E1 09       LD HL, 09E1
0C9A 36 1F          LD(HL)1F
0C9C 23             INC HL
0C9D 36 1C          LD(HL)1C

                    MAIN PROG
0C9F CD 30 0F       Call "joysticks"
0CA2 2A 54 0C       LD HL(0C54)         Fetch and adjust
0CA5 CD ED 0E       Call "CRT Check"    RH CRT address
0CA8 22 54 0C       LD(0C54)HL
0CAB 3E 07          LD A,07
0CAD CD 38 0E       Call "SSH Check"
0CB0 3A 53 0C       LD A(0C53)          Test RH j/s button jump if not
                                        pressed
0CB3 FE FF          CP,FF
0CB5 20 0C          JRNZ 0CC3
0CB7 36 20          LD(HL)space
0CB9 26 0B          LD H,0B             Adjust CRT address
0CBB 3E 07          LD,A,07
0CBD CD 38 0E       Call "SSH check"
0CC0 22 54 0C       LD(0C54)HL          Save new CRT address
0CC3 3A 57 0C       LD A(0C57)          Test RH hole
0CC6 FE 00          CP, 00              indicator, jump if
0CC8 28 1D          JRZ 0CE7            not in hole
0CCA 36 20          LD(HL)space         Blank out RH ship
0CC0 3D             DEC A               Count down time
0CCD 32 57 0C       LD(0C57)A           In black hole,
0CD0 FE EE          CP,EE               jump if not time up
0CD2 20 11          JRNZ 0CE5
0CD4 AF             XOR A
0CD5 32 53 0C       LD(0C53)A           Clear button store
0CD8 32 57 0C       LD(0C57)A           Clear hole store
0CDB 26 0B          LD H,0B             Adjust CRT address
0CDD 22 54 0C       LD(0C54)HL          Save new CRT address
0CE0 3E 07          LD A, 07
0CE2 CD 38 0E       Call "SSH check"
0CE5 18 20          JR 0CE9
0CE7 36 07          LD(HL)07            Print RH ship
0CE9 E5             PUSH HL             Save RH ship position
0CEA 2A 51 0C       LD HL(0C51)         Get LH CRT address
0CED CD ED 0E       Call "CRT check"
0CF0 22 51 0C       LD(0C51)HL          Save LH CRT address
0CF3 3E 18          LD A,18
0CF5 CD 38 0E       Call "SSH check"
0CF8 3A 50 0C       LD A(0C50)          Test LH j/s
0CFB FE FF          CP,FF               button, jump if
0CFD 20 0C          JRNZ 0D0B           not pressed
0CFF 36 20          LD(HL)space         Blank out LH ship
0D01 26 09          LD H,09             Adjust CRT address
0D03 3E 18          LD A,18
0D05 CD 38 0E       Call "SSH check"
0D08 22 51 0C       LD(0C51)HL          Save new CRT address
0D0B 3A 56 0C       LD A(0C56)          Test LH hole
0D03 FE 00          CP,00               indicator, jump if
0D10 28 1D          JRZ 0D2D            not in hole
0D12 36 20          LD(HL)20            Blank out LH ship
0D14 3D             DEC A               Count down time
0D15 32 56 0C       LD(0C56)A           in black hole
0D18 FE EE          CP,EE               jump if not
```

```
0D1A 20 11          JRNZ 0D2D       time up
0D1C AF             XOR A
0D1D 32 50 0C       LD(0C50)A       Clear button store
0D20 32 56 0C       LD(0C56)A       Clear hole store
0D23 26 08          LD H, 08        Adjust CRT address
0D25 22 51 0C       LD(0C51)HL      Save new CRT address
0D28 3E 18          LD A,18
0D2A CD 38 0E       Call "SSH check"
0D2D 18 02          JR 0D31
0D2F 36 18          LD(HL)18        Print LH ship
0D31 CD 2C 0E       Call"Delay"
0D34 36 20          LD(HL)space     Blank out LH ship
0D36 E1             POP HL          Restore RH ship address
0D37 36 20          LD(HL)space     Blank out RH ship
0D39 C3 9F 0C       JP 0C9F
0D3C 00             NOP

                    EXECUTE & INSTRUCT
0D3D EF 1E 53 54 41 52 20
0D44 4D 41 5A 45 1F 1F 20
0D4B 46 69 72 73 74 20 74
0D52 6F 20 72 65 61 63 68
0D59 20 63 65 6E 74 72 65
0D60 2C 77 69 6E 73 2E 1F
0D67 20 48 69 74 20 61 20
0D6E 73 74 61 72 20 26 20
0D75 79 6F 75 20 6C 6F 73
0D7C 65 2E 1F 20 48 69 74
0D83 20 61 20 62 6C 61 63
0D8A 6B 20 68 6F 6C 65 20
0D91 26 20 79 6F 75 20 72
0D98 65 61 70 70 65 61 72
0D9F 20 65 6C 73 65 77 68
0DA6 65 72 65 2D 1F 20 6C
0DAD 61 74 65 72 2E 1F 1F
0DBF 50 72 65 73 73 20 52
0DBB 20 74 6F 20 73 74 61
0DC2 72 74 1F 1F 00
0DC7 C3 CB 0E       JP 0ECB
0DCA 00 00 00 00 NOP

                    SOUND
0DCE D9             EXX
0DCF 21 5C 0C       LD HL,0C5C      Hole, sound data address
0DD2 0E 01          LD C,01         No of notes
0DD4 18 16          JR-0DEC
0DD6 D9             EXX
0DD7 21 5E 0C       LD HL,0C5E      Explode sound data addre:
0DDA 0E 02          LD C,02         No of notes
0DDC 18 0E          JR 0DEC
0DDE D9             EXX
0DDF 21 5C 0C       LD HL,0C5C      Left won,data address
0DE2 0E 04          LD C,04         No of notes
0DE4 18 06          JR 0DEC
0DE6 D9             EXX
0DE7 21 58 0C       LD HL,0C58      Right won, data address
0DEA 0E 04          LD C,04         No of notes
0DEC 16 02          LD D,02         Note length
0DEE 1E FF          LD E, FF        Length modifier
0DF0 46             LD B(HL)        Get note
0DF1 3E 20          LD A,20         Pointer to bit 5
0DF3 CD 53 00       Call 0053       Call "Toggle port 0"
0DF6 10 FE          DJNZ            B-times
0DF8 AF             XOR A
0DF9 1B             DEC DE
0DFA 82             ADD A,D         No of repeats
0DFB 20 F3          JRNZ 0DF0       Jump if repeated
0DFD 23             INC HL          Point to next note
0DFE 0D             DEC C           Decrement note count
0DFF 81             ADD A,C
0E00 28 02          JRZ 0E04        Jump if last note
0E02 18 E8          JR 0DEC
0E04 D9             EXX
0E05 C9             RET
0E06 00             NOP

                    WON
0E07 F1             POP AF
0E08 21 9D 0A       LD HL,0A9D
0E0B 77             LD(HL)A         Print Winning Ship
0E0C F5             PUSH AF
0E0D 23 23          INC HL,INC HL
0E0F 22 18 0C       LD(0C18)HL      Reset cursor
0E12 EF 48 61 73 20 77 6F
0E19 6E 00

0E1B F1             POP AF          find if RH player
0E1C FE 07          CP,07           has won,
0E1E 20 05          JRNZ 0E25       jump if not.
0E20 CD E7 0D       Call "sound"
0E23 18 03          JR 0E28
0E25 CD DE 0D       Call "sound"
0E28 C3 B2 0E       JP 0EB2         For restart
0E2B 00             NOP

                    DELAY
0E2C D9             EXX
0E2D 11 66 66       LD DE,6666
0E30 1B             DEC DE
0E31 7A             LD A,D
0E32 B3             OR E
0E33 20 FB          JRNZ 0E30
0E35 D9             EXX
0E36 C9             RET
0E37 00             NOP

                    SSH CHECK
0E38 E5             PUSH HL
0E39 F5             OPUSH AF
0E3A 7E             LD A(HL)        Test for star
0E3B FE 2E          CP,2E           jump to "explode"
0E3D CA 6F 0E       JPZ 0E6F        if yes
0E40 FE 9E          CP,9E
0E42 CA 07 0E       JPZ 0E07        Test for space
0E45 FE 9D          CP,9D           station,jump
0E47 28 F9          JRZ 0E42        to "won"
0E49 FE 1F          CP,1F           if yes
0E4B 28 F5          JRZ 0E42
0E4D FE 1C          CP,1C
0E4F 28 F1          JRZ 0E42
0E51 FE AC          CP,A0           Test for black hole
0E53 28 03          JRZ 0E58        jump if yes
0E55 F1             POP AF
0E56 E1             POP HL
0E57 C9             RET
0E58 F1             POP AF
0E59 FE 07          CP,07           Test RH player in
0E5B 28 0A          JRZ 0E67        hole, jump if yes
0E5D 3E FF          LD A,FF         Set LH hole
0E5F 32 56 0C       LD(0C56)A       indicator
0E61 E1             POP HL
0E63 CD CE 0D       Call 0DCE       Call sound
0E66 C9             RET
0E67 3E FF          LD A,FF         Set RH hole
0E69 32 57 0C       LD(0C57)A       indicator
0E6C 18 F4          JR-0E61
0E6E 00             NOP

                    EXPLODE
0E6F 11 40 00       LD DE,0040
0E72 06 03          LD B,03
0E74 3E AA          LD A,AA
0E76 E5             PUSH HL
0E77 77             LD(HL)A
0E78 2B 2B          DEC HL, DEC HL
0E7A 77             LD(HL)A         Print
0E7B E1             POP HL          explosion
0E7C E5             PUSH HL
0E7D 23 23          INC HL, INC HL
0E7F 77             LD(HL)A
0E80 E1             POP HL
0E81 E5             PUSH HL
0E82 19             ADD HL,DE
0E83 36 3A          LD(HL)3A
0E85 2B             DEC HL
0E86 77             LD(HL)A
0E87 23 23          INC HL,INC HL   Print explosion
0E89 77             LD(HL)A
0D8A E1             POP HL
0E8B E5             PUSH HL
0E8C ED 52          LDIR
0E8E 36 3A          LD(HL)3A
0E90 2B             DEC HL
0E91 77             LD(HL)A
0E92 23 23          INC HL,INC HL
0E94 77             LD(HL)A
0E95 E1             POP HL
0E96 CD D6 0D       CaLL 0DD6       Call sound
0E99 21 9B 0A       LD HL,0A9B
0E9C D1             POP DE
0E9D 7A             LD A,D
```

JOYSTICK CONTROLS

```
0EB2 21 1A 0B        LD HL,0B1A
0EB5 22 18 0C        LD(0C18)HL      Reset cursor
0EB8 EF 70 72 65 73 73 20
0EBF 52 20 74 6F 20 72 65
0EC6 70 6C 61 79 00
0ECB CD 3E 00        Call 003E       Call CHIN
0ECE FE 52           CP,52           Test for "R" key
0ED0 20 F9           JRNZ 0ECB       Jump if not
0ED2 31 00 10        LP SP,1000      Reset stack pointe
0ED5 C3 60 0C        JP 0C60         For restart
0ED8 00              NOP

                     PRINT RANDOM
0ED9 21 0A 08        LD HL,080A      CRT start address
0EDC 41              LD B,C          No of chars to print
0EDD F5              PUSH AF         Save No of blocks
0EDE ED 5F           LD A,R          Get random No
0EE0 85              ADD L
0EE1 6F              LD L,A          Adjust CRT address
0EE2 72              LD(HL)D         Print character
0EE3 10 F9           DJNZ 0EDE       Repeat to end of block
0EE5 24              INC H           Point to next block
0EE6 F1              POP AF
0EE7 3D              DEC A           Count blocks
0EE8 20 F2           JRNZ 0EDC       Jump if not last block
0EEA C9              RET
0EEB 00 00           NOP

                     CRT CHECK
0EED F5 C5 D5 E5     PUSH AF,BC,DE,  Save registers
                     HL
0EF1 3E 07           LD A,07
0EF3 BC              CP,H            Test for "off top line"
0EF4 20 05           JRNZ 0EFB       Jump if not
0EF6 E1              POP HL
0EF7 26 0B           LD H,0B         Adjust to unscrolled line
0EF9 18 22           JR-0F1D
0EFB 3E 0C           LD A,0C
0EFD BC              CP,H            Test, off unscrolled line
0EFE 20 05           JRNZ 0F05       Jump if not
0F00 E1              POP HL
0F01 26 08           LD H,08         Adjust HL to top line
0F03 18 18           JR 0F1D
0F05 11 40 00        LD DE,0040      Line count displacement
0F08 06 10           LD B,10         Max No of lines to check
0F0A 3E 0B           LD A,0B
0F0C BC              CP,H            Check for unscrolled line
0F0D 20 0A           JRNZ 0F19       Jump if not
0F0F 3E C9           LD A,C9
0F11 BD              CP,L            Test for top left minus 1
0F12 28 14           JRZ 0F28        Jump if yes
0F14 3E FA           LD A,FA
0F16 BD              CP,L            Test for top right plus 1
0F17 28 08           JRZ 0F21        Jump if yes
0F19 19              ADD HL,DE       Add displacement
0F1A 10 EE           DJNZ 0F0A       Jump & check next line
0F1C E1              POP HL          Not CRT edge, so restore
0F1D D1 C1 F1        POP DE,BC,AF
0F20 C9              RET
0F21 E1              POP HL          Hit RH edge of CRT,
0F22 7D              LD A,L          adjust HL to left edge
0F23 D6 30           SUB 30          on same line,
0F25 6F              LD L,A          and jump to
0F26 18 F5           JR 0F1D         return routine
0F28 E1              POP HL          Hit LH edge of CRT
0F29 7D              LD A,L          adjust to right edge
0F2A C6 30           ADD 30          on same line,
0F2C 6F              LD L,A          and jump to
0F2D 18 EE           JR 0F1D         return routine
0F2F 00              NOP

                     JOYSTICKS
0F30 D7 03           RST 10H         Call JS 1 (0F35)
0F32 D7 0F           RST 10H         Call JS 2 (0F43)
0F34 C9              RET
0F35 C5 D5 E5 F5     PUSH BC,DE,HL,  Save registers
                     AF
0F39 21 50 0C        LD HL,0C50      Store address for JS 1
0F3C 11 00 00        LD DE,0000
0E3F 0E 06           LD C,06         Pointer to port 6
0F41 18 0C           JR 0F4F
0F43 C5 D5 E5 F5     PUSH BC,DE,HL,  Save registers
                     AF
0F47 21 53 0C        LD HL,0C53      Store address for JS 2
0F4A 11 00 00        LD DE,0000
0F4D 0E 07           LD C,07         Pointer to port 7
0F4F 3E FF           LD A,FF         Set PI0 to mode 3
0F51 ED 79           OUT(C)A         Port 6 or 7
0F53 3E FC           LD A,FC         Set PI0 direction
0F55 ED 79           OUT(C)A         Port 6 or 7
0F57 3E 03           LD A,03
0F59 0D 0D           DEC C,DEC C
0F5B ED 79           OUT(C)A         Data out,port 5 or 4
0F5D AF              XOR A
0F5E ED 79           OUT(C)A         Data out port 5 or 4
0F60 3E 03           LD A,03
0F62 ED 79           OUT(C)A         Data out, port 4 or 5
0F64 ED 78           IN A(C)
0F66 CB 6F           Test bit 5,A    If bit 5 is zero
0F68 28 04           JRZ 0F6E        FF is loaded into 0C50
0F6A 36 00           LD(HL)00        or 0C53, if not zero
0F6C 18 02           JR 0F70         then 00 is loaded
0F6E 36 FF           LD(HL)FF        into 0C50 or 0C53
0F70 ED 78           IN A(C)         Data in, port 5 or 4
0F72 CB 5F           Test bit 3,A    Test vertical JS pot
0F74 28 0C           JRZ 0F82
0F76 14              INC D
0F77 CB 57           Test bit 2,A    Test horizontal JS pot
0F79 28 01           JRZ 0F7C
0F7B 1C              INC E
0F7C 06 24           LD B,24
0F7E 10 FE           DJNZ 0F7E       Delay
0F80 18 EE           JR 0F70
0F82 CB 57           Test bit 2,A
0F84 20 F5           JRNZ 0F7B
0F86 D5              PUSH DE
0F87 7A              LD A,D          For vertical test
0F88 FE 09           CP,09           Test greater than 9,
0F8A 38 09           JRC 0F95        Jump if not
0F8C FE 18           CP,18           Test greater than 18,
0F8E 01 00 00        LD BC,0000
0F91 30 07           JRNC 0F9A       Jump if yes
0F93 18 08           JR 0F9D         Not vertical centre so jump
0F95 01 40 00        LD BC,0040      Down a line, displacement
0F98 18 03           JR 0F9D
0F9A 01 C0 FF        LD BC,FFC0      Up a line, displacement
0F9D 23              INC HL
0F9E C5              PUSH BC         Save displacement
0F9F 4E              LD C(HL)
0FA0 23              INC HL
0FA1 46              LD B(HL)        CRT address now in BC
0FA2 EB              EX DE,HL
0FA3 E1              POP HL          Displacement now in HL
0FA4 09              ADD HL,BC       Add displacement
0FA5 EB              EX DE,HL
0FA6 73              LD(HL)E
0FA7 2B              DEC HL
0FA8 72              LD(HL)D         Some new CRT address in
                                     store
0FA9 D1              POP DE
0FAA 7B              LD A,E          For horizontal test
0FAB FE 09           CP,09           Test greater than 9
0FAD 38 09           JRC 0FB8        jump if not
0FAF FE 18           CP,18           Test greater than 18,
0FB1 01 00 00        LD BC,0000
0FB4 30 07           JRNC 0FBD       Jump if yes
0FB6 18 08           JR-0FC0
0FB8 01 FF FF        LD BC, FFFF     Move left displacement
0FBB 18 03           JR-0FC0
0FBD 01 01 00        LD BC,0001      Move right, displacement
0FC0 C5              PUSH BC         Save displacement
0FC1 46              LD B(HL)
0FC2 23              INC HL
0FC3 4E              LD C(HL)        CRT address now in BC
0FC4 EB              EX DE,HL
0FC5 E1              POP HL          Displacement now in HL
0FC6 09              ADD HL,BC       Add displacement
0FC7 EB              EX DE,HL
0FC8 72              LD(HL)D
0FC9 2B              DEC HL
0FCA 73              LD(HL)E         Save new CRT address in
                                     store
0FCB F1 E1 D1 C1     POP AF,HL,DE,BC
0FCF C9              RET
0FD0 00              NOP
```

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Lines 10 to 15 clear the screen and set the cursor to the 'Home' position. Lines 291 to 482 decode the move with lines 500 to 580 detecting the 'Nought' or 'Cross'. The winning line combination is checked for by the subroutine between line 2000 and 2330.

```
10    LET Z$=CHR$(27)&"H"&CHR$(27)&"J"
15    PRINT Z$
20    DIM A(3,3)
30    REM**INITIALISE ARRAY
40    FOR X=1 TO 3
41    FOR Y=1 TO 3
42    LET A(X,Y)=6
43    NEXT Y
44    NEXT X
45    LET D=0
50    PRINT" NOUGHTS AND CROSSES"
51    PRINT "THE SQUARES ARE NUMBERED AS
      SHOWN BELOW"
52    PRINT
53    PRINT
54    PRINT "- - - - - - - - - - - - - -"
55    PRINT "|   7   |   8   |   9   |"
56    PRINT "- - - - - - - - - - - - - -"
57    PRINT "|   4   |   5   |   6   |"
58    PRINT "- - - - - - - - - - - - - -"
59    PRINT "|   1   |   2   |   3   |"
60    PRINT "- - - - - - - - - - - - - -"
61    PRINT
62    PRINT
90    PRINT "FOR X TO START TYPE 1, FOR O TO
      START TYPE 0"
100   INPUT C
105   IF C=0 THEN 130
110   IF C=1 THEN 135
120   GOTO 90
130   LET S=0
132   GOTO 285
135   LET S=1
140   GOTO 280
250   PRINT "SQUARE ALREADY USED TRY
      AGAIN"
255   GOTO 290
256   PRINT "MOVE MUST BE IN THE RANGE 1 TO 9,
      TRY AGAIN"
257   GOTO 290
260   PRINT STALEMATE
265   GOTO 2930
280   PRINT "X TYPE IN YOUR MOVE . TO END
      GAME TYPE 10"
282   GOTO 290
285   PRINT "O TYPE IN YOUR MOVE . TO END
      GAME TYPE 10"
290   INPUT T
291   IF T>10 THEN 256
292   IF T<1 THEN 256
295   IF T=10 THEN 2930
306   IF T=1 THEN 460
310   IF T=2 THEN 470
320   IF T=3 THEN 480
330   IF T=4 THEN 430
340   IF T=5 THEN 440
350   IF T=6 THEN 450
360   IF T=7 THEN 400
370   IF T=8 THEN 410
380   IF T=9 THEN 420
400   IF A(3,1)=6 THEN 402
401   GOTO 250
402   LET A(3,1)=S
403   GOTO 600
410   IF A(3,2)=6 THEN 412
411   GOTO 250
412   LET A (3,2)=S
413   GOTO 600
420   IF A(3,3)=6 THEN 422
421   GOTO 250
422   LET A(3,3)=S
423   GOTO 600
430   IF A(2,1)=6 THEN 432
431   GOTO 250
432   LET A(2,1)=S
433   GOTO 600
440   IF A(2,2)=6 THEN 442
441   GOTO 250
442   LET A(2,2)=S
443   GOTO 600
450   IF A(2,3)=6 THEN 452
451   GOTO 250
452   LET A(2,3)=S
453   GOTO 600
460   IF A(1,1)=6 THEN 462
461   GOTO 250
462   LET A(1,1)=S
463   GOTO 600
470   IF A(1,2)=6 THEN 472
471   GOTO 250
472   LET A(1,2)=S
473   GOTO 600
480   IF A(1,3)=6 THEN 482
481   GOTO 250
482   LET A(1,3)=S
483   GOTO 600
500   IFA(X,Y)=6 THEN 520
510   GOTO 530
520   LET A$=" "
530   IF A(X,Y)=1 THEN 550
540   GOTO 560
550   LET A$=" X "
560   IF A(X,Y)=0 THEN 580
570   GOTO 590
```

```
580     LET A$ = " O "
590     GOTO 635
595     REM** PRINT BOARD
600     PRINT Z$
602     LET X = 3
605     PRINT "- - - - - - - - - - - - - - - -"
610     LET Y = 1
620     PRINT "|";
630     GOTO 500
635     PRINT A$;
640     IF Y<3 THEN 700
645     PRINT "|"
650     GOTO 720
700     LET Y = Y + 1
710     GOTO 620
720     IF X>1 THEN 725
721     PRINT "- - - - - - - - - - - - - - - -"
722     GOTO 1000
725     LET X = X - 1
730     PRINT "- - - - - - - - - - - - - - - -"
740     GOTO 610
1000    LET D = D + 1
1005    GOSUB 2000
1007    IF D = 9 THEN 260
1010    IF S = 0 THEN 135
1020    GOTO 130
1990    REM** LEADING DIAGONAL
2000    FOR X = 1 TO 3
2010    LET Y = X
2020    IF A(X,Y) = S THEN 2040
2030    GOTO 2080
2040    NEXT X
2050    GOTO 2900
2070    REM** LAGGING DIAGONAL
2080    FOR Y = 1 TO 3
2090    LET X = 4 - Y
2100    IF A(X,Y) = S THEN 2120
2110    GOTO 2160
2120    NEXT Y
2130    GOTO 2900
2150    REM**ROWS
2160    FOR X = 1 TO 3
2170    FOR Y = 1 TO 3
2180    IF A(X,Y) = S GOTO 2200
2190    GOTO 2220
2200    NEXT Y
2210    GOTO 2900
2220    NEXT X
2230    GOTO 2260
2250    REM** COLUMNS
2260    FOR Y = 1 TO 3
2270    FOR X = 1 TO 3
2280    IF A(X,Y) = S THEN 2300
2290    GOTO 2320
2300    NEXT X
2310    GOTO 2900
2320    NEXT Y
2330    RETURN
2900    IF S = 1 THEN 2920
2910    PRINT "O WINS!!!!!!"
2915    GOTO 2930
2920    PRINT "X WINS!!!!!!"
2930    PRINT "WANT ANOTHER GAME?"
2931    INPUT M$
2932    IF M$ = "Y" THEN 10
2933    IF M$ = "N" THEN 3000
2934    GOTO 2931
3000    END
```

SIGNIFICANT WHAT?

S. Draper

Whilst writing a scientific program for our school's PET recently I came up against the problem of rounding any number to N significant figures. This short routine is the result — it will round any number (within the PETs range) to N significant places whether the number is positive or negative.

```
1000 QT = 10 ↑ (N-1-INT(LOG(ABS(A))))
1010 A2 = ((INT(ABS(QT*A) + 0.5))/QT)*SGN(A)
```

QT is merely an intermediate quantity (QT was used because it is unlikely to have been used in the main program). A is the quantity to be rounded, N the number of figures it is to be rounded to, and A2 the result.

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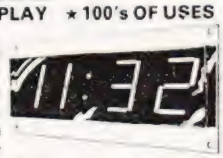

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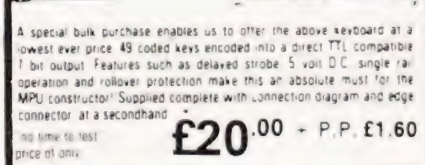

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PRINTOUT

Dear Editor,

Your business readers may be interested in the following anecdote.

No spare discs, the nearest stockists some fifty miles away, and I needed more file space! I had seen templates advertised for modifying discs to enable use of the other side, but could I make my own?

My Horizon uses hard-sectored Shugart drives. So in addition to the write project notches there were sector detect holes through the disc sleeves.

So, a corner was cut off a stout manilla envelope, forming an isoceles triangle having the vertex at the envelope corner and equal sides of 4¼". Slipping this over the appropriate corner of the disc and taking care to keep it firmly located, the position of the sector detect holes and write project notches were marked using face-down carbon paper and thumbnail.

The template was then removed and punched in the position marked, so that those locations could be marked through in pencil onto the disc to be modified.

For the initial trial, an office-type double paper punch was used, but that entailed carefully opening the plastic sleeve and removing the precious disc so that punching could be safely done. The disc was replaced in the sleeve, the latter being resealed with plastic tape, and, using the Horizon disc test utility which writes and reads back a moving pattern the flip side was tested. It passed!

Following this success, other discs were modified using a more refined punching technique. A pliers-type single paper punch (Maun Industries type 2505) was purchased in a W.H. Smith bubble pack for £1.05, and with the addition of a piece of selloptape behind the die to catch the punchings it is possible to punch the sector index holes with the disc in situ. Although the original holes are ⅛", a 3/16" punch is successful if care is taken with the hole locations.

Yours,
Gordon J Mitchell.

Ashleigh Farm,
Gayton-Le-Marsh
Alford
Lincs LN13 0NW

Dear Sir,

I have a Commodore PET 8K with integral cassette and old ROMs. I like the integral concept, it suits the domestic environment better than a jumble of trailing wires linking separate cassette, monitor, processor etc. Unfortunately, there is an increasing trend for software and hardware goodies to be produced for new ROM machines only. I, therefore, decided to update my machine by purchasing a set of new ROMs from Commodore. I was shocked to discover that Commodore have increased the price of the new ROM set from £30 to £108, a swingeing 360% increase.

I have written to Commodore to express my disgust but since Customer Relations are such poor relations I don't expect a reply. I think the latest piece of mischief is designed to sell more new machines.

You will do your readers a service if you publish this letter so that the Commodore policy is widely known. Your readers can then take account of this before parting with their money

Yours faithfully,
J.A. Banks

43, The Drive,
Loughton,
Essex
IG-10-HB

Dear Sir,

Congratulations! You have finally persuaded me to cancel my order for C.T. with my newsagent. Your last issue (October) finally made me blow my top. Here are my hopefully welcome comments on the magazine you now turn out!:-

Starting with the front cover (as good a place as any!) I see you say "Space War — The Final Program?". My God, do you people really think that up and then get somebody to print it for you!! Oh well, on with the show, Super-Brain Report. A Business System! When your magazine first started, it had on the front cover "The new magazine for *small* systems with big ideas." HUH!!

Now on to "Space War" again. I'm not saying it's a lousy program, in fact I'm sure it's very good, but you do say it illustrates some fine string handling routines. Yet again, I'm sure the program does have fine string handling routines, but I would have thought that having published this fact, that you might at least say where they are and explain how and why they do what they are doing!

Still on the subject of programs; how desperate you must be to publish a program such as "SNAP". Before you actually publish your programs (you do actually pay for them don't you?), perhaps you ought to look and see what you've bought. On page 46 it gives an example of the use of the INKEY$ function in an infinite loop. Not a very good way to start program documentation! I mean, you do rant and rave about structured programming, so for crying out loud, make sure you publish some!!

Now listen. There are plenty (and I mean plenty) of magazines that cater for people with the PETs, Apples and Tandys of this world. For the people who are into silly games, and those into Pascal and ALGOL 68, so for God's sake (or at least mine), try to go back to what was a promising format, e.g. how the machine works, how to make extra things for your machine, and how to make your machine do *useful* things!

Having said all this, however, I suppose I must say that your "Problem Page" and "Microlink" are very, very good. Also, this is just the opinion of little old me; someone who bought your very first few magazines in the hope of a really exciting, useful magazine. Someone who had hoped for something British to be really good. But, as ever, not a chance

Yours faithfully,
C.B. Payne

Rose Cottage,
Ewell Minnis,
Dover,
Kent
CT 15 7DY

PS I hope I haven't offended anybody. All I have said is what I believe to be true in my opinion, and is in no way designed to slur anybody's thingy.

Dear Sir,

I was delighted to see the ZX80 extra in your December issue. I bought one to teach my sons the rudiments of computing and I have since been totally occupied in it. Computer buffs may well sneer but it has taught my sons and I a lot (though Boolean logic programs floor me). 1K of memory stops one gabbling on in programs. Both Mr. Bryant and Mark Harrison are to be congratulated on producing programs that are miracles of economy. Lots more please.

Can anyone help me with "Randomise" (lines 20 and 25 respectively in their programs). The ZX80 Handbook doesn't give a working example. Take both lines out and everything still seems to work on my machine. Does anyone know a simple program that proves Randomise (not RND) is functioning? I've tried and got nowhere.

Yours faithfully,
M.E. Martin

Snaresbrook Hall,
Woodford Road,
South Woodford, E.18

Dear Editor,

In reply to Iolo Davidson's letter, to convert decimal into hexadecimal or octal or any other base for that matter, just repeat the function he has already outlined.

The method consists of repeatedly dividing the decimal number by your base number. Listing the remainders, converting to Hex notation i.e. A = 10, B = 11 etc. and reading them in reverse, thus:

Hexadecimal		Octal	
274	2	274	2
17	1	34	2
1	1	4	4
0		0	
i.e. Hex 112		i.e. Oct 422	

Yours faithfully,
J.D. Harrison

14 Bascott Road,
Wallisdown,
Bournemouth,
Dorset

Dear Sir,

I was interested to read T. Mabb's letter (in the December 1980 issue) on Acorn Atom addresses.

However, he is wrong to state (albeit with the help of Dino Dini (?)) that the cursor address is held in addresses DE and DF. These addresses only give the address of the start of the line upon which the cursor lies. The cursor address can be calculated as follows

256 * ?=DF + ?=DE + ?=E0

The address E0 holds a value from 0 to 31 denoting how far the cursor is from the left-hand side of the screen.

Yours sincerly,
Mr R.M.P. Hanson

31 Clayfield Road,
Pocklington,
Near York,
YO4 2RG

Dear Sir,

Regarding Mr Davidson's letter in "Printout" December issue. The quickest and simplest way to get a "Hex" number from a decimal is to, firstly convert the decimal number to binary. Then divide the binary into groups of four digits from the least significant end, these can then be converted directly into a "Hex" number!

eg -

95		= DECIMAL .
0101	1111	= BINARY
5	F	= HEX

Perhaps you could pass this information on to Mr Davidson, via your column, and to other readers.

Yours faithfully,
A.S. Davy

35 Colne Road,
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This pack includes the book and a tape with Sargon prepared to run under NAS-SYS. Also included is a special graphics rom and a PCB giving your NASCOM the ability to switch between two graphics ROMs, your original and the chess ROM. All the above for only £35.00

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This unit allows the NASCOM user to program both 2708 and 2716 EPROMs and complete with operating software only £25.95

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Provides sockets for both 2708 and 2716 EPROMs (up to 16 EPROMs) and also provides a fully decoded socket for the NASCOM 8K BASIC ROM. This board is produced to full NASBUS specification and can be used in "page mode" together with the new NASCOM RAM B. Wait states may be generated on board to allow a NASCOM 1 to run at 4MHz in BASIC. The complete Kit at only £55.00

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EXTRAS

Henry's EPROM Burner. Antex Soldering Irons & Bits.

SOFTWARE

Northstar. CAP-CPP. Cromemco Petsoft. Supersoft. Nascom Games

BOOKS

Very full range of books on 6502. Z80. Languages. Interfacing. Introductory books and games and General Programs

MAGAZINES

Personal Computer World. Computing Today. Practical Computing. Educational Computing. Liverpool Software Gazette. Printout.

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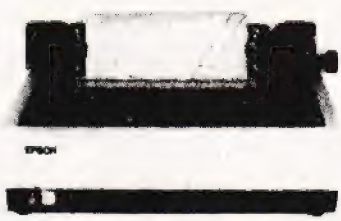

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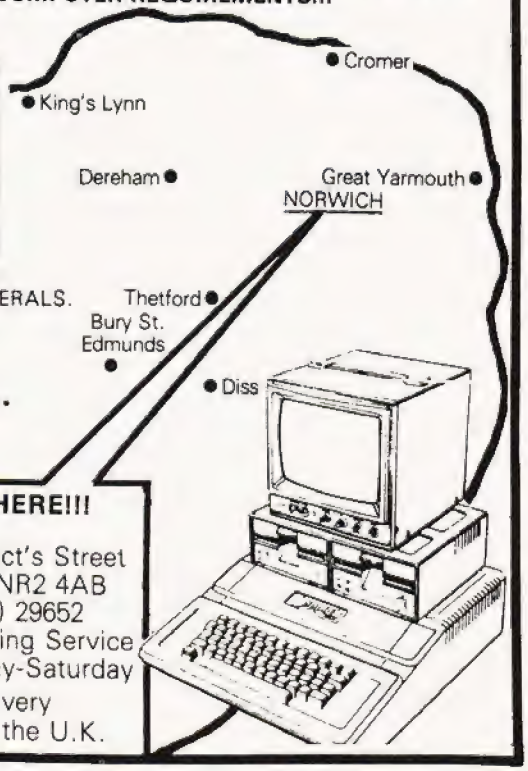

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A systematic listing of what's available in the best consumer guide around.

Having come full circle with out series of guides to equipment, peripherals etc., we now return to the microcomputers themselves. In this month's guide we present an up-to-date listing of all the systems that are currently available in the UK. The layout is exactly the same as last time but, after many requests, we'll explain the cryptic code! Most of the entries are obvious but the memory and m/c notes appear to have been slightly mis-understood. The RAM entry is the amount of user RAM fitted in the machine as standard and the maximum that you can have, 1K/48K for example. In the case of single board computers the second entry is the size of the add-on memory board.

The m/c entry is even more cryptic, if the machine has direct machine code access through a monitor then the figure gives the size of this monitor, if the machine has a disc operating system then the name of this is given, CP/M for example.

Whilst every care is taken in the compilation of these guides it is not unusual to find that a new machine has been launched during the time it takes to print the magazine, or indeed that a manufacturer has upgraded his system. If you know of any systems that are not included please send the information, preferably in the format below, to the Buyers Guide Compiler at our usual address together with the prices and photographs if possible.

ABC Computers

ABC-24
Dist:- Ragen International
Assets House,
17 Elverton Street,
London SW1P 2QG
01-828 2355

CPU	Z80A	**RAM**	64K
I/O	2 SER 1 PARA	**CASS**	–
BASIC	BASIC-80 M BASIC	**Other**	Various
DISC	2x5¼"	**m/c**	CP/M, MP/M

£3,000

Extras:- Two more 5¼" drives, Wordstar, Grafcom packages etc.
Applications:- Integral system with dual discs and VDU

ACT Microcomputers

SYSTEM 800
Dist:- ACT (Computers),
Radclyffe House
66-68 Hagley Rd, Edgbaston,
Birmingham, B16 8PF
021-455 8686
+ growing regional network

CPU	6502	**RAM**	46K
I/O	SER PARA	**CASS**	N/A
BASIC	Yes	**Other**	Various
DISC	2x5¼"	**m/c**	MDOS

£3,950-8,950

Extras:- 8" disc, printers, modems
Applications:- Stand alone business system that can also run most PET software.

Acorn Computers

ATOM
Dist:- Acorn Computers
4A Market Hill
Cambridge
0223-312772

CPU	6502	**RAM**	2K/11K
I/O	BUS PARA	**CASS**	Kansas
BASIC	8K	**Other**	FP option
DISC		**m/c**	YES

£125 kit, £150 built

Extras:- Colour graphics, enhanced BASIC
Applications:- Cased single board with BASIC, can connect to Eurobus

ACORN
Dist:- As ATOM

CPU	6502	**RAM**	1K/8K
I/O	PARA BUS	**CASS**	CUTS
BASIC	NO	**Other**	NO
DISC	NO	**m/c**	2K

£65 upwards

Extras:- Rack based expansion capability inc Prestel.
Applications:- Single board controller with piggy back Hex + I/O.
Reviewed:- Aug '79

ADDS

ADDS SYSTEM 75
Dist:- ADDS (UK) Ltd.
137 High Street
New Malden, Surrey
01-949 1272
Sold through dealer network

CPU	8085A	**RAM**	52K
I/O	SER COMS	**CASS**	N/A
BASIC	YES	**Other**	Fortran uCobol
DISC	2x8"	**m/c**	ADOS

£4,000 upwards, less printer

Extras:- Floppy, printer, system software
Applications:- Complete business system with supplied software and communications interface

Apple Computers

APPLE II
Dist:- Microsense,
Finway Road, Maylands Ave,
Hemel Hempstead,
Herts HP2 7LE
0442-48151
Over 200 regional dealers

CPU	6502	**RAM**	16K/48K
I/O	Various	**CASS**	YES
BASIC	2 versions	**Other**	Various
DISC	OPT	**m/c**	2K

£695 upwards

Extras:- Various discs, colour graphics, I/O
Applications:- Neat cased system with excellent I/O capability including Prestel

APPLE III
Dist:- As APPLE II

CPU	6502A	**RAM**	96K/128K
I/O	Various	**CASS**	–
BASIC	Business BASIC	**Other**	Pascal Fortran
DISC	5¼"	**m/c**	–

Approx £2,500.

Extras:- Up to three more discs. Wide range of peripherals
Applications:- Small business machine but still has overtones of the "personal" market

Atari

ATARI 400
Dist:- Ingersoll Electronics
202 New North Road
London N1 7BL
01-226 1200

CPU	6502	**RAM**	8K/16K
I/O	SER	**CASS**	YES
BASIC	18K	**Other**	
DISC		**m/c**	shared

£400

Extras:- Printer
Applications:- Programmable games system grown up to home computer.

ATARI 800
Dist:- As Atari 400

CPU	6502	**RAM**	16K/48K
I/O	SER	**CASS**	YES
BASIC	18K	**Other**	
DISC		**m/c**	shared

£750

Extras:- Printer, discs, plug in software, modem
Applications:- Expanded version of 400 with wider applications

Athena

ATHENA 8285
Dist:- Butel-Comco Ltd.
50 Oxford Street,
Southampton
Hants SO1 1DL
0703-39890

CPU	8085A	**RAM**	64K
I/O	SER	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	2x5¼"	**m/c**	DOS

£3,380 upwards

Extras:- 8" discs, printer, wide range of software
Applications:- Complete integral desktop system

Attache

ATTACHE
Dist:- Friargrove Systems,
Suite 62, Outer Temple,
222 The Strand,
London WC2R 1BA
01-353 8267

CPU	Z80	**RAM**	64K
I/O	SER	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	2x8"	**m/c**	CP/M

£8,000

Extras:- Hard disc,
Applications:- Complete S100 based system with VDU, printer and software

Commodore Systems

PET
Dist:- Commodore,
360 Euston Road
London NW1 3BL
01-388 5702
+ many regional dealers

CPU	6502	**RAM**	8K/32K
I/O	IEEE PARA	**CASS**	YES
BASIC	8K	**Other**	Forth Pascal
DISC	OPT	**m/c**	

£550 upwards

Extras:- Discs, printer, many options
Applications:- Original complete personal system
Reviewed:- December '79

SUPER PET (8032)
Dist:- As PET

CPU	6502	**RAM**	32K
I/O	IEEE 1 PARA	**CASS**	OPT
BASIC	BASIC 4.0	**Other**	Pascal
DISC	OPT	**m/c**	TIM

£700 approx

Extras:- 5¼" discs. Choice of printers, range of business software
Applications:- "Super" personal computer or small business machine

Compshop

UK 101
Dist:- CompShop
14 Station Road
New Barnet,
Herts EN5 1QW
01-441 2922

CPU	6502	**RAM**	4K/8K
I/O	SER PARA	**CASS**	YES
BASIC	8K	**Other**	NO
DISC		**m/c**	2K

£199 kit, £249 built

Extras:- Memory, I/O, kit or built
Applications:- UK implementation of Superboard

Compucolor

COMPUCOLOR II
Dist:- Dyad Developments
The Priory, Great Milton,
Oxon OX9 7PB.
08446-729.

CPU	8080	**RAM**	8K/32K
I/O	SER PARA	**CASS**	NO
BASIC	YES	**Other**	NO
DISC	5¼"	**m/c**	DOS

£1,200

Extras:- Second disc unit.
Applications:- Integral colour graphics system with limited expansion capabilities.
Reviewed:- June '79 & July '80

Cromemco

CROMEMCO SYSTEM 2
Dist:- Comart Ltd.
PO Box 2,
St Neots,
Huntingdon,
Cambs PE19 4NY
0480-215005

CPU	Z80	**RAM**	64K
I/O	SER PARA.P	**CASS**	N/A
BASIC	Various	**Other**	Various
DISC	2x5¼"	**m/c**	CDOS

£2,095-£7,000
plus Datron & Edinburgh Micro Centre

Extras:- Hard option disc, multiple user capability, printer, etc.
Applications:- Development system, S100 based, with a wide range of software

CROMEMCO Z2H
Dist:- As SYSTEM 2

CPU	Z80A	**RAM**	64K
I/O	SER PARA.P	**CASS**	N/A
BASIC	Various	**Other**	Various
DISC	10Mb Hd	**m/c**	CDOS

£5,373 upwards.

Extras:- Up to 6 hard discs, 8" floppies
Applications:- Development system, Fast data processor and data base with multi-user capability.

CROMEMCO SYSTEM 3
Dist:- As SYSTEM 3

CPU	Z80	**RAM**	64K
I/O	SER PARA.P	**CASS**	N/A
BASIC	Various	**Other**	Various
DISC	2x8"	**m/c**	CDOS

£3,745-£9,000

Extras:- Discs (inc hard), multi-user capability, printers, etc.
Applications:- S100 based professional system with a wide range of applications.

Digital Microsystems

DSC-2
Dist:- Modata Ltd,
30 St Johns Road
Tunbridge Wells,
Kent TN4 9NT
0892-41555

CPU	Z80A	**RAM**	64K
I/O	SER PARA	**CASS**	N/A
BASIC	Yes	**Other**	Various
DISC	2x8"	**m/c**	CP/M

£3,525-7,645

Extras:- Hard disc, extra floppies, various software
Applications:- Business machine of US origin.

DSC-3
Dist:- As DSC-2

CPU	Z80A	**RAM**	64K
I/O	SER PARA	**CASS**	N/A
BASIC	Yes	**Other**	Various
DISC	2x8"	**m/c**	CP/M

£3,445-6,995

Extras:- Hard disc, extra floppies.
Applications:- Can use one serial interface in RS422 mode and act as a Master/Slave in a network.

HDS-4000
Dist:- As DSC-2

CPU	Z80A	**RAM**	64K
I/O	SER PARA	**CASS**	N/A
BASIC	Yes	**Other**	Various
DISC	2x8" + Hd	**m/c**	CP/M

£6,745-7,645

Extras:- More disc storage
Applications:- Choice of two sizes of hard disc make for medium sized DP use

Hewlett Packard's superb desk-top system, the HP85.

Equinox

Series 5000
Dist:- Equinox Computer Systems,
16 Anning Street,
New Inn Yard,
London EC2A 3HB
01-739 2387

CPU	Z80	**RAM**	16K/56K
I/O	2 SER 1 PARA	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	2x5¼"	**m/c**	CP/M

£1,500 - £2,500

Applications:- S100 based commercial, scientific or educational usage

Equinox 200
Dist:- As Series 5000

CPU	Z80	**RAM**	64K/512K
I/O	6 SER 1 PARA	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	10 Mb Cart	**m/c**	—

£7,500 upwards

Extras:- Cartridge discs up to 1200 Mb
Applications:- Cartridge disc based S100 multi user system

Equinox 300
Dist:- As Series 5000

CPU	16 bit	**RAM**	64K/256K
I/O	6 SER	**CASS**	N/A
BASIC	YES	**Other**	—
DISC	10 Mb Cart	**m/c**	—

£10,000 upwards

Extras:- Cartridge discs up to 1200 Mb
Applications:- Sixteen bit micro based multi-user system

Series 8000
Dist:- As Series 5000

CPU	Z80	**RAM**	64K/256K
I/O	2 SER 1 PARA	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	2-4 8"	**m/c**	CP/M

£2,500 - £5,000

Applications:- Multi user upgrade of 5000 with greatly increased storage capacity

Eurocalc

EUROC
Dist:- Eurocalc Ltd.
128/132 Curtain Road,
London EC2

01-729 4555
+ Regional Distribution network soon

CPU	8080	**RAM**	64K
I/O	PARA	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	2x8"	**m/c**	CP/M

£8,000

Extras:- Printers, WP keyboard, hard disc
Applications:- Plessey manufactured system supplied complete with software and hardware

Exidy

SORCERER
Dist:- Liverport Data Products
The Ivory Works,
St Ives, Cornwall
0736-798157
+ regional dealers

CPU	Z80	**RAM**	16K/48K
I/O	SER PARA	**CASS**	2
BASIC	Plug In 8K	**Other**	On disc
DISC	OPT	**m/c**	4K

£749 upwards

Extras:- Discs, printer, S100 adapter, ROM PACs
Applications:- Keyboard based system using 'plug-in' software and expanding to discs

Gemini

GEMINI
Manuf.:- Gemini Microcomputers,
Oakfield Corner,
Sycamore Road,
Amersham, Bucks
02403-22307

CPU	Z80	**RAM**	64K
I/O	Serial	**CASS**	N/A
BASIC	YES	**Other**	—
DISC	2x5¼"	**m/c**	CP/M

£575 - £1,075

Heath Electronics

HEATHKIT H8
Dist:- Heath Electronics,
Bristol Road
Gloucester GL2 6EE
0452-29451
+ London shop (01-636 7349)

CPU	8080	**RAM**	4K/56K
I/O	Various	**CASS**	YES
BASIC	YES	**Other**	Various on disc
DISC	OPT	**m/c**	4K

£275 upwards

Extras:- Discs, printer, VDU
Applications:- Bus based kit system of superb quality, large expansion possible

Hewart Microelectronics

HEWART 6800S
Dist:- Hewart Microelectronics
95 Blakelow Road,
Macclesfield,
Cheshire SK11 7ED
0625-22030

CPU	6800	**RAM**	16K/32K
I/O	SER PARA	**CASS**	2
BASIC	OPT 8K	**Other**	Pascal
DISC		**m/c**	1K/2K

£299 inc. keyboard

Extras:- 6809 upgrade, floppy discs using FLEX, case
Applications:- Naked 6800 development system.

HEWART 6800 MK4
Dist:- As 6800S

CPU	6800	**RAM**	16K/48K
I/O	Choice	**CASS**	2
BASIC	OPT	**Other**	OPT
DISC	OPT		**m/c**

£160 upwards.

Extras:- SS50 range of boards.
Applications:- Naked bus based system, found useful in education/control.

Hewlett Packard

HP 85
Dist:- Hewlett Packard
King Street Lane,
Winnersh,
Wokingham, Berkshire
0734-784774

CPU	CUSTOM	**RAM**	16K/32K
I/O	IEEE SER	**CASS**	CART
BASIC	32K	**Other**	
DISC	OPT	**m/c**	NO

£2,300

Extras:- All HP range of goodies.
Applications:- Integral printer system for desktop scientific use.
Reviewed:- April '80 & June '80

Interec Data Systems

SUPERBRAIN
Dist:- Sun Computers,
138 Chalmers Way
North Feltham Trading Estate
Feltham, Middx.
01-751 6695.

CPU 2xZ80
I/O SER
BASIC YES
DISC 2x5¼"

RAM 32K/64K
CASS N/A
Other Various
m/c CP/M

£1,950 upwards

Extras:- 8" disc, standard software.
Applications:- S100 bus based complete unit of smart desktop type.

Ithaca Intersystems

ITHACA INTERSYSTEM 2
Dist:- Transam,
59-61 Theobalds Road
London WC1
01-405 5240
+ regional dealers

CPU Z80A
I/O Various
BASIC YES
DISC 5¼" or 8"

RAM 8K/64K
CASS N/A
Other Various
m/c CP/M

£700 upward

Extras:- Full range of S100 boards to IEEE spec.
Applications:- Flexible system that can be adapted to a wide range of uses.

ITT Consumer Products

ITT 2020
Dist:- Telefusion Ltd.,
61 Queens Square
Bristol
0272-211446
+ many regional stockists

CPU 6502
I/O Various
BASIC Various
DISC OPT

RAM 16K/48K
CASS YES
Other Pascal
m/c 2K

£750 - £1,500

Extras:- Discs, Prestel, printers.
Applications:- As Apple II, compatible UK version with standard colour graphics.
Reviewed:- March '80

LSI Computers

SYSTEM M-TWO
Dist:- LSI Computers
Copse Road, St Johns,
Woking, Surrey GU21 1SX
04862-23411

CPU 8085
I/O SER
BASIC YES
DISC 2x8" 1 x Hd

RAM 64K
CASS –
Other –
m/c –

Applications:- Small to medium sized business

Luxor

ABC 80
Dist:- CCS Microsales,
7 The Arcade,
Letchworth, Herts.
04626-73301

CPU Z80
I/O IEEE SER
BASIC 16K
DISC 2x5¼"

RAM 16K/40K
CASS YES
Other Pascal
m/c 2K

£749

Extras:- Mainly software, I/O
Applications:- Complete cased system, Viewdata compatible

Microdata Computers

MICROLINK 1
Dist:- Microdata Computers,
Belvedere Works, Bilton Way,
Pump Lane Industrial Estate,
Hayes, Middx UB3 3ND
01-848 9871

CPU Z80/F8
I/O SER PARA
BASIC 8K
DISC NO

RAM 16K/32K
CASS CUTS 1200Bd
Other Pascal soon
m/c 3K

£3,500 upwards

Extras:- Printer, modem, etc.
Applications:- Portable data terminal using plasma flat screen display

Micro V

MICROSTAR 45
Dist:- Microsense
Finway Road, Maylands Avenue
Hemel Hempstead,
Herts HP2 7LE
0442-48151
+ small dealer network

CPU 8085A
I/O SER
BASIC YES
DISC 2x8"

RAM 64K
CASS N/A
Other Various
m/c *DOS CP/M

£4,800

Extras:- 20 M6 hard disc, VDU, printer
Applications:- Multi user business system

Midwest Scientific Instruments

MSI 6800 SYSTEMS
Dist:- Strumech,
Portland House, Coppice Side
Brownhills, Walsall
West Midlands
05433-4321

CPU 6800
I/O SER
BASIC YES
DISC OPT

RAM 16K/56K
CASS OPT
Other Various
m/c 1K+FDOS

£1,200 upwards

Extras:- Floppies, hard disc, printer, VDU.
Applications:- Ready built SS50 system expanding to full "System 12" with hard disc.

Nascom Microcomputers

NASCOM 1
Dist:- Nascom
92 Broad Street
Chesham, Bucks HP5 3ED
02405-75151
+ regional network

CPU Z80
I/O SER PARA
BASIC OPT
DISC

RAM 1K/6K
CASS YES
Other
m/c 1K

£125

Extras:- Motherboard, RAM, printer.
Applications:- Full keyboard machine code system, expandable.

NASCOM 2
Dist:- As NASCOM 1

CPU Z80A
I/O SER PARA
BASIC 8K
DISC

RAM 1K/227K
CASS Kansas
Other
m/c 2K

£225

Extras:- Printer, RAM, case, discs.
Applications:- Low cost kit system, developed from Nascom 1.
Reviewed:- February '80

National Panasonic

PANASONIC JD800/840
Dist:- Panasonic Business Equip.
9 Connaught Street
London W2 2AY
01-262 3121
+ regional distributors

CPU 8085A
I/O SER
BASIC YES
DISC 2x8"

RAM 56K
CASS N/A
Other Cobol
m/c CP/M

£4,275 (hardware)
£8,000 upwards for packages

Extras:- Printers and software from regional distributors.
Applications:- Complete small business system with software support.

Netronics

ELF II
Dist:- Newtronics,
255 Archway Road
London N6
01-348 3325

CPU 1802
I/O PARA
BASIC OPT
DISC

RAM ¼/4K
CASS OPT
Other
m/c 1K

£60

Extras:- Motherboard, RAM, I/O.
Applications:- Low cost kit for Hex programming.
Reviewed:- October '79

EXPLORER 85
Dist:- As ELF II
255 Archway Road
London N6
01-348 3325

CPU	8085	**RAM**	4K
I/O	PARA	**CASS**	YES
BASIC	8K OPT	**Other**	
DISC		**m/c**	2K

£285 upwards

Extras:- Normal S100 goodies, case.
Applications:- Kit, S100 based.
Reviewed:- June '80

Newbear

77-68
Dist:- Newbear,
40 Bartholomew Street
Newbury, Berks.
0635-30505
+ 2 regional shops

CPU	6800	**RAM**	4K/56K
I/O	Various	**CASS**	YES
BASIC	OPT	**Other**	NO
DISC		**m/c**	1K

£40 upwards

Extras:- 6809 upgrade, I/O, discs.
Applications:- Rack based kit system.

Nexos

Nexos 4500
Dist:- Nexos Office Systems
Centre Point, New Oxford St,
London WC1 1QA
01-240 5795

CPU	8086	**RAM**	192K
I/O	VDU Printer	**CASS**	–
BASIC	–	**Other**	–
DISC	2x8"	**m/c**	–

£7,500

Extras:- Various software packages
Applications:- Complete business system with VDU and printer

North Star

NORTHSTAR HORIZON
Dist:- Comart Ltd.,
P.O. Box 2, St Neots
Huntingdon, Cambs PE19 4NY
0480-215005
+ many regional dealers

CPU	Z80	**RAM**	32K/56K
I/O	SER PARA	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	2x5¼"	**m/c**	CP/M

£1,600 - 2,000

Extras:- Discs, VDU, printer.
Applications:- S100 based system with good software support.

Ohio Scientific Instruments

SUPERBOARD II, (C1)
Dist:- Mutek,
Quarry Hill, Box, Wiltshire.
0225-743289
+ many regional

CPU	6502	**RAM**	4K/8K
I/O	PARA BUS	**CASS**	YES
BASIC	8K	**Other**	NO
DISC	NO	**m/c**	2K

£150
cased + psu + mod = C1 @ £220

Extras:- Discs, Memory, case.
Applications:- Naked single board with BASIC, modified display for UK market.
Reviewed:- July '79

CHALLENGER, C2
Dist:- As SUPERBOARD II

CPU	6502	**RAM**	4K/32K
I/O	SER PARA	**CASS**	Kansas
BASIC	8K	**Other**	NO
DISC	OPT	**m/c**	2K

£349

Extras:- Disc, printer, memory.
Applications:- 4 slot backplane machine, upgraded system.

CHALLENGER, C4
Dist:- As SUPERBOARD II

CPU	6502	**RAM**	8K/32K
I/O	SER PARA	**CASS**	YES
BASIC	8K	**Other**	NO
DISC	OPT	**m/c**	4K

£395

Extras:- Disc, printers, etc.
Applications:- Upgraded C2 with colour graphics.

CHALLENGER, C8P
Dist:- As SUPERBOARD II

CPU	6502	**RAM**	8K/32K
I/O	SER PARA	**CASS**	YES
BASIC	8K	**Other**	NO
DISC	OPT	**m/c**	4K

£475

Extras:- Disc, printers, etc.
Applications:- Upgraded C2 with colour graphics.

CHALLENGER, C3
Dist:- As SUPERBOARD II

CPU	6502 6800 + Z80	**RAM**	48K/58K
I/O	Various	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	2x8"	**m/c**	DOS

£2,450

Extras:- VDU, printer, software
Applications:- Triple CPU system for business use etc.

Ontel

JEMINI
Dist:- Jaserve Ltd.
Stanhope Road,
Camberley, Surrey
0276-62282

CPU	8085A	**RAM**	52K/64K
I/O	SER	**CASS**	N/A
BASIC	YES	**Other**	Various

£9,200 upwards

Extras:- WP Software, printers, etc.
Applications:- VDU based package system.

Periflex

PERIFLEX 630/48
Dist:- Sintrom
Arkwright Road, Reading
Berks. RG2 0LS
0734-85464

CPU	Z80	**RAM**	48K
I/O	Various	**CASS**	N/A
BASIC	various	**Other**	Various
DISC	2x5¼"	**m/c**	CP/M2

£2,500

Extras:- VDU, printers, S100 board set
Applications:- S100 based systems.

PERIFLEX 1024/64
Dist:- As 630/48

CPU	Z80	**RAM**	64K
I/O	Various	**CASS**	N/A
BASIC	Various	**Other**	Various
DISC	2x8"	**m/c**	CP/M 2

£3,300

Extras:- VDU, printers.
Applications:- S100 based boxed computer.

Powerhouse

POWERHOUSE 2
Dist:- Powerhouse,
5 Alexandra Road
Hemel Hempstead,

CPU	Z80A	**RAM**	32K/64K
I/O	SER PARA.P	**CASS**	YES
BASIC	Yes	**Other**	No

Herts HP2 5BS
0442-48422

DISC OPT **m/c** 2K

£1,250

Extras:- Graphics, I/O, printer.
Applications:- 5" VDU based system used in scientific and industrial control.

POWERHOUSE 3
Dist:- As POWERHOUSE 2

CPU Z80A **RAM** 32K/64K
I/O SER PARA.P **CASS** N/A
BASIC Yes **Other** Various
DISC 2x5¼" **m/c** CP/M

£2,250-£2,750

Extras:- Graphics, I/O, printer.
Applications:- 9" VDU based system with potential DP and small business applications.

Powertran

PSI COMP 80
Dist:- Powertron Electronics
Portway Industrial Estate
Andover, Hants SP10 3MN
0264-64456

CPU Z80 **RAM** 3K/32K
I/O Various **CASS** Kansas
BASIC 2K **Other** NO
DISC **m/c** 1K

£255

Applications:- Mathematical/number crunching with special on-board chip.

Rair

BLACK BOX
Dist:- Rair Ltd.
30-32 Neal Street,
London WC2H 9PS
01-836 4663

CPU 8085A **RAM** 32K/64K
I/O SER **CASS** N/A
BASIC Various **Other** Various
DISC 2x5¼" **m/c** CP/M

£2,500 upwards

Extras:- VDU's, printer, hard and floppy discs.
Applications:- Disc based professional system capable of handling up to 16 terminals.

Research Machines

RML 380Z
Dist:- Research Machines
P.O. Box 75,
Mill St, Oxford
0865-49791

CPU Z80 **RAM** 16K/56K
I/O Various **CASS** YES
BASIC YES **Other** Various
DISC OPT **m/c** 3K

£897 upwards

Extras:- Graphics, printer, etc.
Applications:- Educational system of high quality.

Rockwell

AIM 65
Dist:- Pelco Electronics
Enterprise House,
83-85 Western Road
Hove, Sussex BN3 1UB
0273-722155
+ several regional outlets

CPU 6502 **RAM** 1K/4K
I/O SER PARA **CASS** 2
BASIC 8K op **Other**
DISC **m/c** 8K

£265 upwards

Extras:- Discs, RAM, VDU, cases, etc.
Applications:- Versatile single board with single line display and thermal printer.
Reviewed:- Dec '79

Sanyo

SYSTEM 7000
Dist:- Memory Computers (UK)
Denjon House,
11 Denmark Street,
London WC2
021-455 8686

CPU Z80 **RAM** 32K/64K
I/O SER **CASS** N/A
BASIC Yes **Other** Various
DISC 2x5¼" **m/c** CP/M

£6,950 (complete systems)

Extras:- 8" floppies, printers, etc.
Applications:- Complete VDU based system well established in Europe.

SGS Ates

NANOCOMPUTER
Dist:- SGS Ates/Midwich
9 Churchgate Street,
Old Harlow, Essex CM17 0JS
0279-412605

CPU Z80 **RAM** 4K/16K
I/O RS232 2xPARA **CASS** YES
BASIC 8K opt **Other**
DISC **m/c** 2K

£240 upwards

Extras:- Experimenter systems, full system capability.
Applications:- Educational single board that can grow to kill system.
Reviewed:- Aug '79

Sinclair Research

ZX80
Dist:- Science of Cambridge
6, Kings Parade
Cambridge, Cambs CB2 1SN
0223-311488

CPU Z80A **RAM** 1K/16K
I/O PAR/BUS **CASS** YES
BASIC YES **Other** NO
DISC NO **m/c**

£80 kit, £100 built

Extras:- Kit or ready built, PSU, 16K RAM 8K BASIC
Applications:- Touch keyboard, low-cost beginners/educational system
Reviewed:- June '80

Sharp Electronics

MZ-80K
Dist:- Sharp UK Ltd.
Thorn Road, Newton Heath,
Manchester M10 9BE
061-205 2333
+ growing regional

CPU Z80 **RAM** 6K/34K
I/O PARA **CASS** YES
BASIC 14K **Other**
DISC **m/c** 4K

£480 to £599

Extras:- Discs, printer, I/O adaptor
Applications:- Japanese desktop system expanding to business market.

PC 1211
Dist:- As MZ-80K

CPU Unknown **RAM**
I/O NO **CASS** YES
BASIC YES **Other** NO
DISC NO **m/c** NO

£120 approx inc cassette adaptor

Extras:- Printer adaptor soon.
Applications:- 1424 step BASIC programmable handheld computer using LCD display.

Smoke Signal

SMOKE SIGNAL CHIEFTAIN
Dist:- Strumech
Portland House, Coppice Side,
Brownhills, Walsall

CPU 6800 **RAM** 32K/56K
I/O SER SS50 BUS **CASS** N/A
BASIC YES **Other** Various

West Midlands
05433-4321
+ Windrush

DISC OPT **m/c** 1K – DOS

£3,000

Extras:- Floppies, printers, VDUs.
Applications:- Mainly supplied to education and research although suitable for business.

Sord

M100 ACE Mk III
Dist:- Exleigh Business Machines Ltd.
11 Market Place, Penzance
Cornwall TR18 2JB
0736-66577
+ some regional outlets, Midas etc

CPU Z80 **RAM** 48K
I/O Various **CASS** N/A
BASIC YES **Other** Fortran
DISC 2x5¼" **m/c**

£2,259

Extras:- More discs, Colour graphics
Applications:- Personal or small business machine from Japan based on the S100 bus.

M203 Mk III
Dist:- As M100 ACE

CPU Z80A **RAM** 64K
I/O Various **CASS** N/A
BASIC YES **Other** Various
DISC 2x5¼" **m/c** CAP.BOS

£2,979

Extras:- 2 x 8" floppies, 2 more 5¼" floppies
Applications:- Process control, wordprocessing, business system with CAP/CPP software.

M223 Mk III
Dist:- As M100 ACE

CPU Z80A **RAM** 64K
I/O Various **CASS** N/A
BASIC YES **Other** Various
DISC 2x5¼" **m/c** CAP.BOS

£3,489

Extras:- 4 x 8" floppies, more 5¼" floppies, up to 4 x 8 Mb Hard disc.
Applications:- As the M203 but with a full S100 bus to allow system expanson.

Southwest Technical Products

SWTP 6800/6809
Dist:- Southwest Technical
38 Dover Street,
London W1X 3RB
01-491 7507

CPU 6800 6809 **RAM** 8K/56K
I/O Various **CASS** YES
BASIC Various **Other** Various
DISC OPT **m/c** 2K

Extras:- Discs, printer, VDU.
Applications:- SS50 based system with good software support

Tandy Corporation

TRS-80 Level 1 & 2
Dist:- Tandy Corp.,
Bilston Road, Wednesbury
West Midlands WS10 7JN
021-556 6101
+ regional shops

CPU Z80 **RAM** 4K/48K
I/O OPT **CASS** YES
BASIC 2 versions **Other** Fortran
DISC OPT **m/c** 4K

£380 - £560

Extras:- Discs, printers, I/O.
Applications:- Top selling system with "separates" approach
Reviewed:- November '79

TRS-80 II
Dist:- As TRS-80

CPU Z80 **RAM** 32K/64K
I/O SER PARA **CASS** N/A
BASIC YES **Other**
DISC 8" **m/c**

£2,000 upwards

Extras:- Printer, disc.
Applications:- Upgraded business version of Model I.

Tangerine Computers

MICROTAN 65
Dist:- Tangerine Computers
Forehill, Ely, Cambs.
+ regional dealers
0353-3633

CPU 6502 **RAM** 1K/48K
I/O BUS **CASS** OPT
BASIC OPT 10K **Other** NO
DISC NO **m/c** 1K

£69 upwards

Extras:- Tanex board for I/O, BASIC, etc + racking,cases.
Applications:- Machine code system, kit or built that expands to a full computer.
Reviewed:- June '80

MICRON
Dist:- As MICROTAN 65

CPU 6502 **RAM** 8K
I/O 1 SER 4 PARA **CASS** YES
BASIC 10K **Other** NO
DISC NO **m/c** 3K

£395 inc

Extras:- RAM, Discs, I/O rack system
Applications:- Cased built system with excellent expansion possibilites
Reviewed:- October '80

Technalogics

TECS
Dist:- Technalogics
8 Egerton St.Liverpool,
Merseyside L8 7LY
051-724 2695
+1 Regional Distributor

CPU 6800 **RAM** 16K/56K
I/O SER PARA **CASS** 2
BASIC 3K **Other** YES
DISC OPT **m/c** 4K

Extras:- Discs/Memory Prestel Software
Applications:- Prestel/Teletext terminal option to home system
Reviewed:- May '79

Texas Electronic Instruments

TEI 208-212
Dist:- Abacus,
62 New Cavendish Street,
London W1M 7LD
01-580 8841

CPU Choice **RAM** 32K/60K
I/O PARA SER **CASS** N/A
BASIC YES **Other** Various
DISC 2x5¼" **m/c** CP/M

£3,535-4,497

Extras:- 8" discs (212) printers, hard disc soon
Applications:- Integral VDU models forming the basis of a business system

Texas Instruments

TI 99/4
Dist:- Texas Instruments,
European Consumer Division,
Manton Lane, Bedford MK41 7PA
0234-67466
+ dealer network

CPU 9900 **RAM** 16K
I/O PARA BUS **CASS** 2
BASIC 14K **Other** NO
DISC OPT **m/c** 12K

£995

Extras:- Discs, speech synthesiser
Applications:- Colour graphics machine with "plug-in" software Needs US TV, soon to change

Transam

TRITON
Dist:- Transam,
59-61 Theobalds Road,
London WC1
01-405 5240

CPU 8080 **RAM** 1K/3K
I/O PARA BUS **CASS** YES
BASIC Various **Other** Pascal
DISC OPT **m/c** Various

£294 to £1,000

Extras:- Cases, Discs, Motherboard, Assembler package
Applications:- Versions available for most requirements, from educational to research.
Reviewed:- May '80

TUSCAN
Dist:- As TRITON

CPU	Z80	**RAM**	1K/8K
I/O	SER PARA	**CASS**	YES
BASIC	OPT	**Other**	Pascal
DISC	OPT	**m/c**	2K

£195 upwards

Extras:- Casing, VDU option, discs, Firmware, S100 boards
Applications:- S100 based kit, development style system. Also ready built

Vector Graphic

SYSTEM B
Dist:- Sintrom.
Arkwright Road Reading.
Berks RG2 0LS
0734-85464
+ many regional

CPU	Z80	**RAM**	64K
I/O	SER PARA	**CASS**	N/A
BASIC	Various	**Other**	Various
DISC	2x5¼"	**m/c**	CP/M 2

£3,200 upwards

Extras:- Printer, software, S100 boards
Applications:- Serious computing package complete with VDU and software

VECTOR GRAPHIC 28??
Dist:- As SYSTEM B

CPU	Z80	**RAM**	64K
I/O	SER PARA	**CASS**	N/A
BASIC	Various	**Other**	Various
DISC	2x8"	**m/c**	CP/M 2

£3,995 upwards

Extras:- Printers, S100 boards, software
Applications:- Data processing and scientific/industrial computing. Terminal based system.

VECTOR GRAPHIC 3030
Dist:- As SYSTEM B

CPU	Z80	**RAM**	64K
I/O	SER PARA	**CASS**	N/A
BASIC	Various	**Other**	Various
DISC	2x5¼" 32M6HB	**m/c**	CP/M 2

£TBA

Extras:- Printers, S100 boards, software.
Applications:- Hard disc based terminal system for DP

VIP
Dist:- As SYSTEM B

CPU	Z80A	**RAM**	56K
I/O	1 SER 3 PARA	**CASS**	--
BASIC	—	**Other**	—
DISC	5¼"	**m/c**	CP/M

£2,125

Extras:- Vector Graphic range
Applications:- Complete system with single disc and VDU. Six slot S100 bus

Video Genie

VIDEO GENIE
Dist:- Lowe Electronics
Bentley Bridge, Chesterfield Road,
Matlock, Derbyshire DE4 LEF
0629-2817
+ dealer network

CPU	Z80	**RAM**	16K/48K
I/O	PARA BUS	**CASS**	YES
BASIC	10K	**Other**	
DISC		**m/c**	2L

£425 inc VAT

Extras:- Printer, discs via Tandy.
Applications:- HONG KONG copy of TRS-80 and which also runs Level 2 software

Xerox

DIABLO 3000
Dist:- Business Computers.
The Pagoda, Theobald Street,
Borehamwood, Herts WD6 4RT
01-207 3344

CPU	8085	**RAM**	32K/64K
I/O	SER	**CASS**	N/A
BASIC	YES	**Other**	DACL
DISC	2x8"	**m/c**	DOS

£8,950-£15,000

Extras:- Business software, Printer, Communications adapter
Applications:- Complete business system that can be multi-tasked Price includes software.

DIABLO RANGER 3200
Dist:- As DIABLO 3000

CPU	8080	**RAM**	32K/64K
I/O	SER	**CASS**	N/A
BASIC	YES	**Other**	DACL
DISC	2x8"	**m/c**	DOS

£10,865-£50,000

Extras:- Up to 4 discs, Up to 2 hard discs, Printers, Communications adapter.
Applications:- Complete system that can run up to eight jobs simultaneously, price includes software.

Zenith Data Systems

ZENITH Z89
Dist:- Zenith Data Systems.
Heath Electronics.
Bristol Road,
Gloucester GL2 6EE
0452-29451
+ London shop 01-636 7349

CPU	Z80	**RAM**	16K/64K
I/O	SER	**CASS**	OPT (H88)
BASIC	YES	**Other**	Various
DISC	5¼"	**m/c**	8K

£1,570 upwards

Extras:- Dual 8" discs, printer
Applications:- Integrated system of very high quality, also available as a kit
Reviewed:- June '80

ZENITH Z11
Dist:- As Z89

CPU	LSI 11	**RAM**	16K/32K
I/O	Various	**CASS**	N/A
BASIC	YES	**Other**	Various
DISC	OPT2x8"	**m/c**	N/A

£1,250

Extras:- Discs, printer, VDU
Applications:- LSI 11 compatible 16 bit system.
Reviewed:- June '80

The TI 990/4 home computer system.

COMPUTERAMA

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Computers

Pet. 40 col. new ROMS green screen, large keyboard	8K	£399
	16K	£499
	32K	£599
Pet. 80 col. new DOS	32K	£840
	64K	POA
TRS-80 system, includes VDU cassette recorder & P.S.U.	4KLI	£320
	16KLII	£475
TRS-80 CPU, includes UHF TV modulator & P.S.U.	4KLI	£250
	16KLII	£375
TRS-80 expansion interface	32K	£275
Apple II includes BASIC interpreter	16K	£599
	32K	£625
	48K	£649
Colour monitor system		£399
Video Genie includes on-board cassette recorder, output to VDU or UHF TV (TRS-80 BASIC)	16K	£299
Video Genie expansion bus box	S100	£245

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Alan Brook
Computerama

Disc drives

Pet compatible

Commodore Dual		£635
Computhink	400K	£595
Dual	800K	£795
	1.6Mb	£1195

TRS-80 compatible, all with case & P.S.U.

Teac 40 track single	£225
Dual	£399
Quad	£775
77 track single	£325
Dual	£595
Quad	£1155
Shugart SA 400 Single	£229
Apple 11 twin-drive	£456
Controller card	£49

Diskettes 5¼" double sided double density £32 for 10
8½" " " " " £36 for 10

Printers

Electrosensitive Type

Quick Printer II (33 col) (TRS-80, serial & parallel inputs)	£129

Thermal Type

Phantom 400 (40 col) (with dot graphics)	£229
800 (80 col)	£329

Impact Dot-Matrix

Commodore Tractor 80 col (for Pet) all Pet graphics	£375
Epson Tractor 80 col Pet graphics	£325
Epson Tractor 80 col High Res. graphics	£399
Anadex DP8000	£425
Anadex DP9500	£825
Paper Tiger with 8 char. sizes & High Res. graphics	£595

Interfaces

Pet/TRS-80 to UHF TV	£25
Pet/TRS-80 to RS232 output	£65
Pet to RS232 in/out	£90
Pet to RS232 decoded output	£150
Pet to RS232 decoded in/out	£175
Pet multiplexer for networking up to 20 Pets	£350
Pet/TRS-80 to S100, 4 slot	£112
Pet/TRS-80 to Centronics	£45
Pet to Centronics decoded	£69

Monitors

12"	£69
12" (green screen)	£79

List of programmes available on request.

Cables

Pet/IEEE	£20
IEEE/IEEE	£25
RS232 Plug to socket	£25
RS232 Plug to plug	£25

For others please ring

C12 **Blank Cassettes**
10 for £4
100 for £35

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Electrosensitive for QPII	£3.50 per 2 roll pack
Thermal for Phantom 400, TCM 100	£4.10 per 2 roll pack
Phantom 800, TCM 200	£3.90 per roll pack
Impact, single part sprocket punched 9½ × 11 for Commodore, Epson, Anadex Dolphin & Paper Tiger, fanfold strippable	£9.50 per box 2000 sheets

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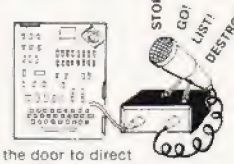

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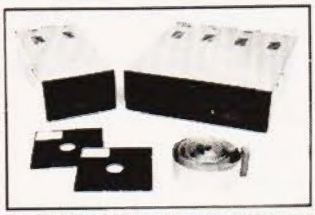

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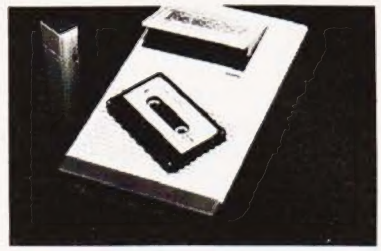

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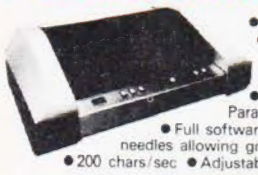

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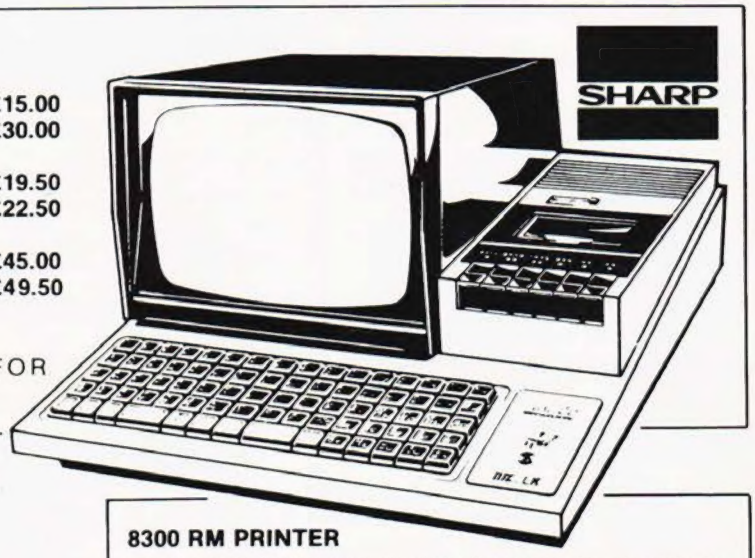

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